DENSITY, NEST-SITE AND ROOST-SITE CHARACTERISTICS, HOME-RANGE, HABITAT-USE, AND BEHAVIOR OF WHITE-HEADED WOODPECKERS: DESCHUTES & WINEMA, N.F. OR

DENSITY, NEST-SITE AND ROOST-SITE CHARACTERISTICS, HOME-RANGE, HABITAT-USE, AND BEHAVIOR OF WHITE-HEADED WOODPECKERS: DESCHUTES AND WINEMA NATIONAL FORESTS, OREGON

by

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Abstract. The White-headed Woodpecker (*Picoides albolarvatus albolarvatus*) is a sensitive species in Oregon and until now little information has been available on its specific habitat needs on the east slope of the Cascade Mountains--its primary range in Oregon. To gain a better understanding of the White-headed Woodpecker, I evaluated several aspects its ecology. I estimated the density of White-headed Woodpeckers and associated species during the 1993 breeding season on 15 study areas within the Deschutes and Winema National Forests of central and south-central Oregon. White-headed woodpeckers reached their highest density in study areas that contained ≥ 37% old-growth ponderosa pine (*Pinus ponderosa*). Densities of other species were highly variable. I described characteristics of 16 nests and 52 roosts of the White-headed Woodpecker on three study areas in the Winema National Forest. Diameter at breast height (dbh) and height of trees used by White-headed Woodpeckers for nesting and roosting differed significantly (Mann-Whitney *U*-test: $U = 604$, $P = 0.007$; $U = 146.5$, $P = 0.000$, respectively). Most nests and roosts were in ponderosa pine. Mean dbh of nests was 80 cm and mean dbh of roosts was 60 cm. Mean height of nest trees was 3 m and mean height of roost trees was 7 m. Typically nests were low to the ground ($\bar{x} = 1.4$ m). All nests were in completely dead substrates. Eighty-three percent of the roosts were in snags. The majority of nests (87%) were in moderately decayed substrates; 66% of the roosts in dead substrates were moderately decayed. All nests and 96% of the roosts were in ponderosa pine forest types. Mean canopy closure was 24% at nests and 44% at roosts. The majority of nests were in partial-cut old-growth (31%) and overstory removal (44%) ponderosa pine stands, and the majority of roosts were in uncut and partial-cut old-growth ponderosa pine stands (70%). Eighty-five percent of the roosting observations were in cavities.

Minimum convex polygon (MCP) home ranges for individual White-headed Woodpeckers were 212 ha (median; range = 172-324 ha) and 342 ha (median; range = 171-704 ha) for contiguous and fragmented sites, respectively. Contiguous sites were predominantly old-growth ponderosa pine, and the fragmented site was a mosaic of all ages of coniferous forest. White-headed Woodpecker home ranges contained 37-92% old-growth ponderosa pine. Home ranges were more variable on fragmented than predominantly old-growth sites ($F_{0.05(1),6,4} = 6.16.$, $P < 0.05$). White-headed Woodpeckers selected home ranges that emphasized old-growth ponderosa pine within the landscape and did not establish home ranges at random.

I also report information on the behavior, foraging strategies, and morphometrics of White-headed Woodpeckers.

Current management strategies do not specifically provide protection for White-headed Woodpeckers, and the continued harvest of large-diameter ponderosa pine could negatively impact this species that depends on this resource. Results of this study provide information on the status of White-headed Woodpeckers on these two National Forests and provide specific guidelines for habitat management.

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The landscape that makes you vulnerable also makes you strong.

--Terry Tempest Williams

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BACKGROUND

In 1988 an administrative rule (OAR 635-100-040) directed the Oregon Department of Fish and Wildlife to maintain a Sensitive Species List. This list was developed in 1989 and the White-headed Woodpecker (*Picoides albolarvatus* Cassin) was initially categorized as a sensitive species. In 1991 the list was further divided into four sub-categories, and the White-headed Woodpecker was listed as "Critical."

The White-headed Woodpecker is a forest-dwelling species unique to the western United States and Canada. These birds range from south-central British Columbia, north-central Washington, and northern Idaho, south to southern California, and western Nevada (Bent 1939; American Ornithologists' Union 1957, 1976). The species consists of two subspecies: *P. a. albolarvatus* (Cassin), which occupies the entire range except for southernmost California, and *P. a. gravirostris* (Grinnell), which is restricted to the higher mountains of southern California. In Oregon, they are uncommon and occur primarily east of the Cascades where a major portion of the old-growth ponderosa pine (*Pinus ponderosa*) forest has been extensively harvested in the last 60-70 years--few remnant stands exist today.

The White-headed Woodpecker uses various habitats within its range, but in the Pacific Northwest its preferred habitat is ponderosa pine forests (Cooper 1969, Ligon 1973, Weber and Cannings 1976). In the Sierra Nevada Mountains of California, White-headed Woodpeckers typically inhabit mixed-conifer forests (Morrison and With 1987, Morrison et al. 1985, Milne and Hejl 1989, Raphael and White 1984), suggesting that they are not restricted to pine-dominated habitats.

The White-headed Woodpecker is non-migratory throughout its range (Bent 1939, Weber and Cannings 1976) and its abundance is similar in summer and winter (Morrison and With 1987). White-headed Woodpeckers breed and overwinter in the same area, which allows these birds to better maintain their territory and nest sites than migratory species (von Haartman 1968). Robinson (1957) reported that White-headed Woodpeckers are paired during the winter and are responsive to their mates and engage in some form of courtship or pair reinforcement behavior. This same behavior was observed among White-headed Woodpeckers in central Oregon (R. Dixon pers. obs.).

The White-headed Woodpecker nests in moderately-decayed snags, stumps, and leaning logs (Weber and Cannings 1976; Bull 1980; Raphael 1981; Raphael and White 1984; Milne and Hejl 1989). Because this species is small-billed (and thus lacks strong excavating abilities), a shortage of decayed wood limits its nesting options and reproductive success. In addition to decay stage, snag density is one of the best predictors for nest site selection among cavity-nesting species (Raphael 1981).

The White-headed Woodpecker forages primarily by gleaning insects from the trunk, branches, and foliage of large-diameter live ponderosa pine trees (Koch et al. 1970, Bull 1980, Morrison and With 1987). It often flakes and chips away at bark, then peers into cracks and crevices (Ligon 1973). Large-diameter ponderosa pines, with their extensive surface area and deep cracks, shelter an abundance of insects (Bull et al. 1986, Raphael and White 1984) and thus represent essential forage sites. Bull et al. (1986) found that when dbh (diameter at breast height)

was considered, White-headed Woodpecker foraging sites could be distinguished from all other species except Williamson's sapsuckers. In another study (Raphael and White 1984), the White-headed Woodpecker was more aligned with nuthatches than other woodpeckers in its overall foraging pattern.

Because White-headed Woodpeckers forage on large-diameter (>53 cm dbh) live ponderosa pines and nest in moderately-decayed snags, the removal of large pines along the east slope of the Cascade Mountains may eliminate essential White-headed Woodpecker habitat. In this study, I describe the association of the White-headed Woodpecker with its habitat and provide management agencies with specific guidelines for providing appropriate habitat for these "Critical" birds. If the White-headed Woodpecker depends on old-growth ponderosa pine forests for survival, we must provide adequate amounts of this habitat to maintain sustainable populations.

I. DENSITY OF WHITE-HEADED WOODPECKERS AND ASSOCIATED SPECIES, DESCHUTES AND WINEMA NATIONAL FORESTS

Abstract. I estimated the density of White-headed Woodpeckers (*Picoides albolarvatus albolarvatus*) and associated species during the 1993 breeding season on 15 study areas within the Deschutes and Winema National Forests of central and south-central Oregon. White-headed woodpeckers reached their highest density in study areas that contained ≥ 37% old-growth ponderosa pine (*Pinus ponderosa*). Densities of other species were highly variable. The total density in birds per 40 ha for all species ranged from 124.79 at Wildhorse 91 (WI) to 395.46 at Canyon Creek (CC). The highest number of species was found at Black Butte (24) and the lowest at Blue Jay (7).

Key words: Density; old-growth ponderosa pine; Picoides albolarvatus; *point-count; White-headed Woodpecker.*

INTRODUCTION

The White-headed Woodpecker is a sensitive species in the state of Oregon because little is known about its distribution, population densities, and specific habitat needs. Many authors report the White-headed Woodpecker's close association with ponderosa pine forest types (Cooper 1969, Ligon 1973, Weber and Cannings), but habitat associations can vary geographically. Milne and Hejl (1989) reported that in the Sierra Nevada Mountains of California, White-headed Woodpeckers are less restricted to pine-dominated habitats than previously suggested. My primary objective was to evaluate the distribution of White-headed Woodpeckers and to determine whether or not they were more abundant in ponderosa pine dominant forest types. My second objective was to obtain information on the presence and density of associated bird species.

STUDY AREAS

The 15 study areas are in the Deschutes and Winema National Forests of central and south-central Oregon. I established and censused 11 of these areas during a

1991 White-headed Woodpecker study. I added 4 sites on the Winema National Forest in 1993: Wildhorse Ridge (WR), Doe Butte (DB), S'Ocholis (SO), and Yoss Ridge (YR). Each study area was 219-993 ha in size and 853-1768 m in elevation. Principal land uses include timber harvesting, fuel-wood cutting, big game hunting, and livestock grazing.

BLACK BUTTE

Black Butte (BB) (44°22′N, 121°37′W) is located 10 km northwest of Sisters, Oregon (Jefferson and Deschutes counties), at elevations between 975 and 1341 m. Extensive tracts of old-growth ponderosa pine characterize Black Butte and comprise 67% of the forested area. A portion of this study area is administered by the Sisters Ranger District as an old-growth management unit. The remainder of the study area is comprised of nonforested land (Black Butte Swamp and Glaze Meadow), quaking aspen (Populus tremuloides), lodgepole/snowbrush-manzanita (*Pinus contorta/Ceanothus velutinus-Arctostaphylos uva-ursi*), and all ages of coniferous forest.

Ponderosa pine is the sole overstory dominant in the 993-ha study area with the understory layer dominated by one or more of the following species: lodgepole pine (*Pinus contorta*); white fir (*Abies concolor*); Douglas fir (*Pseudotsuga menziesii*); incense-cedar (*Calocedrus decurrens*); and western juniper (*Juniperus occidentalis*). Snow-brush (*Ceanothus velutinus*), bitter-brush (*Purshia tridentata*), manzanita (*Arctostaphylos uva-ursi*), and chinquapin (*Castanopsis chrysophylla*) dominate the shrub layer. The herbaceous layer consists primarily of fescue (*Festuca idahoensis*), needlegrass (*Stipa thurberiana*), sedge (*Carex spp.*), and

bracken (*Pteridium aquilinum*). Plant nomenclature follows Hitchcock (1973).

METOLIUS

The Metolius (ME) study area (44°28′N, 21°37′W) is located about 23 km northwest of Sisters, Jefferson County, Oregon, at approximately 853-1158 m elevation. This 908-ha tract exemplifies old-growth ponderosa pine forests of the central Oregon Cascade Range. Bitter-brush and manzanita dominate the shrub layer and fescue is the predominant grass. Fifty-nine percent of the Metolius contains old-growth ponderosa pine, 22% contains old-growth mixed-conifer, and 19% consists of coniferous forest in various silvicultural treatments. Topography varies from the nearly flat bench along the Metolius River to the steep west slope of Green Ridge (Franklin et al. 1972).

The Metolius Research Natural Area (RNA), a 581-ha tract established in June 1931, lies within the overall study area and is administered by the Sisters Ranger District. Ground fires periodically burned nearly all portions of the RNA prior to the initiation of fire control programs around 1910 (Franklin et al. 1972). For a detailed description of the RNA see Franklin et al. (1972).

COLD SPRING

Cold Spring (CS) (44°19′N, 121°37′W) is located 6 km northwest of Sisters, Deschutes County, Oregon, at 975-1097 m elevation. The 443-ha area contains 37% old-growth ponderosa pine, interspersed with clearcuts, shelterwoods, and overstory removals. Ponderosa pine (*Pinus ponderosa*) dominates the overstory with one or more of the following tree species co-dominant: lodgepole pine; white fir; and Western juniper. The understory is characterized by a variety of shrub and

herbaceous species including snow-brush, bitter-brush, manzanita, fescue, needlegrass, squirrel-tail (*Sitanion hystrix*), and sedge (*Carex spp.*).

MELVIN BUTTE

Melvin Butte (MB) (44°12´N, 121°36´W) is located 10 km south of Sisters, Deschutes County, Oregon, at 1158-1463 m elevation. Because of its mosaic of habitat types and silvicultural treatments, this 848-ha area provided an ideal backdrop for comparative density studies.

Ponderosa pine forest types dominate this study area (96%) and one or more of the following tree species exists in the understory: lodgepole pine; white fir; Douglas fir; and Western juniper. Bitter-brush and manzanita dominate the shrub understory and snow-brush is subordinate when present. Needlegrass, squirreltail (*Sitanion hystrix*), and fescue are the most common herbaceous species. Old-growth ponderosa pine comprises 26% of the study area. Engelmann spruce (*Picea engelmannii*) bottomlands comprise 3% of the study area and are dominated by Engelmann spruce, Douglas fir, and white fir, with ponderosa pine present as scattered old-growth and lodgepole pine subordinate (Volland 1988). The remainder of the study area consists of an array of silvicultural treatments, two perennial springs, and a cinder pit.

WHISKEY SPRING

Whiskey Spring (WS) (44°28´N, 121°34´W) is located 19 km north of Sisters, Jefferson County, Oregon, at elevations between 1158 and 1463 m. This 386-ha tract is characterized by mixed-conifer forest types and contains no old-growth ponderosa pine. The tree layer is composed of ponderosa pine, white fir,

Douglas fir, and incense-cedar. The shrub layer consists of snow-brush, bitter-brush, manzanita, and chinquapin. Fescue, needlegrass, squawcarpet, prince's-pine (*Chimaphila umbellata*), and sedge (*Carex spp.*) make up the ground cover.

The entire study area was harvested for timber between 1972 and 1989. Ninety-two percent of the area was harvested as an overstory removal in 1975 (D. Rowe, pers. comm.) and 1989, with the resulting even-aged stands in advanced early to mid-seral stages. The remainder of the study area contained clearcuts, shelterwoods, and precommercial thins. A portion of the study area was privately owned.

CANYON CREEK

Canyon Creek (CC) (44°30´N, 121°43´W) is located 27 km northwest of Sisters, Jefferson County, Oregon, at elevations ranging from 975 to 1189 m. The 219-ha area consists of 31% old-growth mixed-conifer forest interspersed with clearcuts and commercial thins, and dissected by a swift, cold, clear stream (Canyon Creek). The tree layer is composed of ponderosa pine, western larch (*Larix occidentalis*), white fir, Douglas-fir, and incense cedar. Snow-brush, chinquapin, greenleaf manzanita, prince's-pine, and snowberry (*Symphoricarpos albus*) comprise the shrub layer. Twinflower (*Linnaea borealis*), bracken, and sedges dominate the ground cover.

FIRST CREEK

First Creek (FC) (44°29´N, 121°40´W) is located in Jefferson County, Oregon, 23 km northwest of Sisters at elevations ranging from 884 to 975 m. The 432-ha study area consists primarily of ponderosa pine forest types (94%) with the

remaining 6% mixed-conifer/snowberry/forb. Thirty-six percent of the area is mature ponderosa pine forest that was partially cut approximately 30 years ago. Sixty-one percent of the area was harvested as an overstory removal cut in 1985 and the remainder was clearcut in 1985. Ponderosa pine, western larch, and lodgepole pine dominate the tree layer. Bitterbrush and greenleaf manzanita dominate the shrub layer with squaw-carpet occasional. The ground cover is composed of fescue, needlegrass, squirreltail, or sedge. An intermittent stream (First Creek) dissects the study area.

TROUT CREEK

Trout Creek (TC) (44°17′N, 121°37′W) is located 5 km west of Sisters, Deschutes County, Oregon, at elevations between 1036 and 1158 m. Relatively flat in topography, this area is traversed by an intermittent stream and also contains a small gravel pit. Like Melvin Butte, Trout Creek was also ideal for studies of habitat use because of its structural diversity. The two major cover types in the 915-ha study area are ponderosa pine/bitterbrush-manzanita/fescue stands, which cover 58% of the area, and stands that consist primarily of ponderosa pine/bitterbrush-snowbrush/fescue that cover the remaining 42%. Fourteen percent of the study area is old-growth ponderosa pine that was partially cut prior to 1960 (D. Rowe, pers. comm.). Although these stands had been partially cut, they mimicked the structure of old-growth forests. Since 1960, more intensive even-aged timber management has dominated, resulting in a mosaic pattern of clearcuts, shelterwoods, overstory removals, commercial, and pre-commercial thins cut as recently as 1987.

BLUE JAY

Blue Jay (BJ) (42°56′N, 121°32′W) is located on the Chiloquin Ranger District of the Winema National Forest, 21 km northeast of Sand Creek, Klamath County, Oregon. Blue Jay varies in elevation from 1384 to 1433 m. The 260-ha tract includes the 85-ha Blue Jay Research Natural Area (RNA), established in March of 1971, to exemplify ponderosa pine/bitterbrush/needlegrass and lodgepole pine/bitterbrush/needlegrass communities characteristic of the central portion of the pumicite deposits resulting from the eruption of Mount Mazama (Crater Lake) (Franklin et al. 1972). Blue Jay RNA is administered by the Chiloquin Ranger District, Winema National Forest.

Eighty-six percent of the study area is old-growth ponderosa pine with the remaining area comprised of a lodgepole swale and small (7 ha) clearcut. Quaking aspens occur along basalt rimrock areas and moist swales. The plant community is dominated by ponderosa pine, lodgepole pine, bitterbrush, and needlegrass associated with sedge and squirreltail.

Fire scars on ponderosa pine indicate ground fires periodically burned the area prior to initiation of fire control programs in 1910; according to these fire scars, the last wildfire occurrence was about 1916 (Franklin et al. 1972). For a more detailed description of the study site, see Franklin (1972).

WILDHORSE 91

Wildhorse 91 (WI) (42°54′N, 121°37′W) is located 16 km from Sand Creek, Klamath County, Oregon, at elevations between 1372 and 1433 m. Approximately 30 years ago, 94% of this 251-ha tract was either partially cut or commercially

thinned and represents advanced early to mature seral stages of ponderosa pine. The remaining area is an uncut lodgepole swale. Wildhorse contains no old-growth ponderosa pine.

YA WHEE PLATEAU

Ya Whee Plateau (YW) (42°30´N, 121°41´W) is located 16 km southeast of Chiloquin, in Klamath County, Oregon, on the Chiloquin Ranger District of the Winema National Forest at elevations between 1707 and 1768 m. In this 389-ha study area, the white fir overstory was removed in the late 1970s. In 1989, the stand was reentered and the remaining large ponderosa pines were harvested. These harvests left Ya Whee with no old-growth ponderosa pine, 83% overstory removal mixed-conifer, and 17% mature partial-cut mixed-conifer. Ya Whee lies adjacent Saddle Mountain and south of S'Ocholis Canyon on the Sprague River.

WILDHORSE RIDGE

Wildhorse Ridge (WR) (42°54´N, 121°31´W) is located 56 km northeast of Chiloquin, in Klamath County, Oregon, at elevations between 1384 and 1479 m. An extensive tract of old-growth ponderosa pine characterizes Wildhorse Ridge and comprises 98% of the study area. The remainder is uncut mature lodgepole pine. Ponderosa pine and lodgepole pine are the overstory dominants in the 896-ha study area and bitter-brush dominates the shrub layer. The herbaceous layer consists primarily of needlegrass and sedges (*Carex spp.*).

DOE BUTTE

Doe Butte (DB) (43°01´N, 121°25´W) is located about 76 km northeast of Chiloquin, Klamath County, Oregon, at elevations between 1468 and 1668 m.

Extensive tracts of old-growth ponderosa pine characterize Doe Butte and comprise 86% of the study area. The remainder of the study area is comprised of 6% overstory removal ponderosa pine, 1% shelterwood ponderosa, and 6% clearcut.

Ponderosa pine is the overstory dominant in the 832-ha study area and includes one or more of the following tree species in the understory: sugar pine (*Pinus lambertiana*); lodgepole pine; and white fir. The shrub layer is dominated by bitter-brush. The herbaceous layer consists primarily of needlegrass and sedges (*Carex spp.*).

S'OCHOLIS

S'Ocholis (SO) (42°32′N, 121°37′W) is located on the Chiloquin Ranger District of the Winema National Forest, 20 km east of Chiloquin, Klamath County, Oregon. S'Ocholis varies in elevation from 1311 to 1452 m. The 969-ha tract is comprised of 42% mature partial-cut ponderosa pine, 16% mature overstory-removal ponderosa pine, 21% precommercial-thin ponderosa pine, and 20% nonforest. Nonforested areas are comprised of bluegrass scabland dominated by sandberg bluegrass, onespike oatgrass, small fescue, and barestem lomatium. The topography is flat to convex microrelief of ridgelines, benches, and heads of escarpments (Volland 1988). Open areas are scattered with Western juniper, ponderosa pine, and big sagebrush. The dominant habitat type on the study area is ponderosa pine/bitterbrush/fescue dominated by ponderosa pine, Western juniper, mountain mahogany, bitterbrush, Idaho fescue, and squirreltail. Other common plants are western needlegrass, goosefoot violet, phacelia, ross sedge,

manzanita squawcarpet, and rockcress mentzelia.

YOSS RIDGE

Yoss Ridge (YR) (42°45′N, 121°37′W) is located approximately 38 km northeast of Chiloquin, Klamath County, Oregon, at elevations between 1385 and 1610 m. (The extended study area for telemetry ranged from 1385 - 1707 m). The forested area of Yoss Ridge is comprised of 49% old-growth ponderosa pine, 29% overstory removal ponderosa, 3% shelterwood ponderosa, 10% mature and old-growth lodgepole pine, 7% shelterwood lodgepole pine, and 3% burn. The remainder of the study area is nonforested land.

Ponderosa pine is the sole overstory dominant in the 986-ha study area and includes one or more of the following tree species in the understory: lodgepole pine; sugar pine; and white fir. The shrub layer is dominated by bitter-brush, snow-brush, and manzanita. The herbaceous layer consists primarily of needlegrass and sedges (*Carex spp.*).

METHODS

I conducted bird counts from 19 April 1993 to 29 May 1993, using the variable-circular plot (VCP) method to estimate the number of birds per count period. I tallied all birds seen or heard at a station and estimated the horizontal ground distance from the plot center to each bird. Although the primary objective was to estimate the density of White-headed Woodpeckers, I recorded all species detected. The sampling design and monitoring protocol followed that outlined by Region 6 (Bull et al. 1991) and Garton and Bate (1993). Using a hip-chain to accurately measure distances, I spaced VCP points at 250-m intervals along

randomly placed transects across each study area. Each transect was marked with surveyor's tape at 50-m intervals and each VCP station double-flagged.

I began counts at official sunrise and completed them by 1100 hours. I did not conduct counts when wind speeds exceeded 15-20 mph or during heavy rains. Upon arrival at the first station, header information was recorded: National Forest and district number, site, visit, date, observer, julian date, start time, beginning cloud cover, wind (Beaufort Scale of Wind Force), temperature, and precipitation. In addition, I waited for three minutes to allow the birds to adjust to the disturbance. After the three minute wait, I began a five minute recording period. During this time I recorded the species, type of detection (aural, visual, both), and horizontal ground distance to the bird from plot center. To avoid observer biases, each observer visited each VCP. I varied censusing patterns to account for time of day. I sampled VCPs twice at intervals of one to two weeks.

I estimated density using the computer program Variable Circular Plot (VCPS) Version 1.3 (Copyright, E.O. Garton 1995), which incorporates the ordered distance method (Patil et al. 1982).

RESULTS

ALL SPECIES DENSITIES

Density estimations were based solely on my observations because of the discrepancy in the number of detections and effective distances between observers. Therefore all density estimates are based on one visit to each point count station. There was a high degree of variability in bird densities among study areas. The total density in birds per 40 ha for all species ranged from 124.79 at

Wildhorse 91 (WI) to 395.46 at Canyon Creek (CC) (Table 1). The highest number of species was found at Black Butte (24) and the lowest at Blue Jay (7). Black Butte is predominantly old-growth ponderosa pine, but contains large, open meadows, a swamp, quaking aspen stands, and riparian areas. Likewise, Blue Jay is predominantly old-growth ponderosa pine, but a much smaller study area than Black Butte, and perhaps the low species richness is simply an artifact of size. Individual species likewise showed a great deal of variability among study areas.

Northern Flickers were most abundant at Cold Spring and S'Ocholis, which both contain large open areas suitable for ground feeding. Williamson's Sapsuckers were most abundant at Whiskey Spring, which is predominantly mixed-conifer forest. Red-naped Sapsuckers were most abundant at First Creek, which contains a riparian area. Downy Woodpeckers were present only at Wildhorse 91. This is likely attributable to the presence of moist areas that contain quaking aspen (*Populus tremuloides*). Hairy Woodpeckers were detected at all but four study areas reaching their greatest abundance on predominantly old-growth ponderosa pine sites. Black-backed Woodpeckers were detected at only one study area, Whiskey Spring, a predominantly mixed-conifer forest containing atypical habitat for Black-backed Woodpeckers. Pileated Woodpeckers were present on the Metolius. The east side of the Metolius study area grades from old-growth ponderosa pine into old-growth mixed-conifer dominated by Douglas-fir, white fir, and incense cedar. These birds were most abundant at Canyon Creek, which is predominantly mature to old-growth mixed-conifer.

Olive-sided Flycatchers were most abundant at Cold Spring, a mosaic of

old-growth ponderosa pine (37%) broken up by shelterwood cuts and clearcuts. Olive-sided Flycatchers were frequently observed calling from the tops of large-dbh live ponderosa pine trees in shelterwoods. Western Wood Pewees were most abundant at Black Butte and occurred at only one other study area, Cold Spring. I combined Dusky and Hammond Flycatchers into one group, *Empidonax* flycatchers. These flycatchers were present on all 15 study areas and reached their greatest abundance on the Metolius.

Steller's Jays occurred at 8 of the 15 study areas and were most abundant at Cold Spring. Gray Jays were detected only at Canyon Creek. Mountain Chickadees were present on all study areas and were most abundant at Trout Creek. White-breasted Nuthatches were missing from the three mixed-conifer sites (Whiskey Spring, Canyon Creek, and Ya Whee) as well as Blue Jay and S'Ocholis. Red-breasted Nuthatches were present on all study areas and were most abundant at Wildhorse 91. Pygmy Nuthatches were absent from all but one study area on the Winema National Forest (S'Ocholis), and from First Creek and the two mixed-conifer sites on the Deschutes National Forest (Whiskey Spring and Canyon Creek). They were most abundant at Cold Spring.

House Wrens were most abundant at Cold Spring, likely attributable to the mosaic of clearcuts and shelterwoods present on this study area. Golden-crowned Kinglets were detected only at Wildhorse Ridge. Townsend's Solitaires were most abundant at S'Ocholis, which contains large open flats dotted with ponderosa pine, Western juniper, and mountain mahogany. Hermit Thrushes were most abundant on the three mixed-conifer sites--Whiskey Spring, Canyon Creek, and Ya Whee--

but were present at lower densities on the Metolius and Doe Butte. American Robins were absent from all but one of the Winema sites (S'Ocholis) and present at all but one of the Deschutes sites (Whiskey Spring). They were most abundant at Melvin Butte.

Solitary Vireos were detected at only three sites, Black Butte, Metolius, and S'Ocholis. Yellow-rumped Warblers, the most abundant of all species, were detected at all sites but Blue Jay. Black-throated Gray Warblers were detected only at Black Butte and the Metolius, both predominantly old-growth ponderosa pine. Hermit Warblers (*Dendroica occidentalis*) and Townsend's Warblers (*Dendroica townsendi*) were detected on the Metolius, Whiskey Spring, and Canyon Creek. Because these two species sometimes hybridize, and because their songs can be difficult to distinguish, they were combined into one category for analysis (*Dendroica spp.*).

Green-tailed Towhees were most abundant at Melvin Butte, which contains a dense shrub layer--bitterbrush, manzanita, and snowbrush--providing excellent habitat for this species. Rufous-sided Towhees were present at Black Butte, Cold Spring, Melvin Butte, and Trout Creek, all of which contain a dense shrub layer. Chipping Sparrows were present on all 15 study areas and reached their greatest abundance at Canyon Creek. Dark-eyed Juncos were one of the most abundant species encountered in the study and were present on all but two study areas (Wildhorse 91 and S'Ocholis). Fox Sparrows were detected on five study areas (Black Butte, Cold Spring, Melvin Butte, Trout Creek, S'Ocholis, and Yoss Ridge) and were most abundant at S'Ocholis.

Brown-headed Cowbirds were present at all but five study areas. They were most abundant at Melvin Butte, one of the most fragmented sites. Western Tanagers were most abundant on the Metolius. It is interesting to note that Brown-headed Cowbirds--which often parasitize Western Tanager nests--were absent from the Metolius, where Western Tanagers reached their highest density. Pine Siskins were detected only at Ya Whee and S'Ocholis. Cassin's Finches were present at 10 of 15 sites and were most abundant on the Metolius.

The following species were detected, but at numbers too low to obtain density estimates: Black-headed Grosbeak (*Pheucticus melanocephalus*), Ruffed Grouse (*Bonasa umbellus*), and Blue Grouse (*Dendragapus obscurus*). Canada Geese (*Branta canadensis*) flew over Black Butte, Metolius, Wildhorse 91, Doe Butte, and S'Ocholis. One Brown Creeper (*Certhia americana*) was observed between stations at Black Butte. Common Ravens (*Corvus corax*) were observed flying over all study areas, but Canyon Creek. Evening Grosbeaks (*Coccothraustes vespertinus*) were observed at Melvin Butte, Whiskey Spring, First Creek, Trout Creek, S'Ocholis. I observed a Great Blue Heron (*Ardea herodias*) at Black Butte--there is a rookery at Black Butte Swamp. A Golden-crowned Sparrow (*Zonotrichia atricapilla*) was observed at Cold Spring and a Great Horned Owl (*Bubo virginianus*) at Wildhorse 91. Golden Eagles (*Aquila chrysaetos*) were observed at Black Butte and Whiskey Spring. A MacGillivray's Warbler (*Oporornis tolmiei*) was observed at Canyon Creek and a Nashville Warbler (*Vermivora ruficapilla*) at Black Butte. A Mountain Bluebird (*Sialia currucoides*) was observed at S'Ocholis. A Mourning Dove (*Zenaida macroura*) was observed at Trout Creek.

Ospreys (*Pandion haliaetus*) were observed on the Metolius--and nested on the Metolius Research Natural Area. Pygmy Owls (*Glaucidium gnoma*) were heard at Wildhorse 91 and Wildhorse Ridge. Ruby-crowned Kinglets (*Regulus calendula*) were observed at Black Butte and Trout Creek. Red-tailed Hawks (*Buteo jamaicensis*) were observed on the Metolius, Whiskey Spring, First Creek, Wildhorse 91, and Yoss Ridge. A Red-winged Blackbird (*Agelaius phoeniceus*) was observed at Black Butte. I observed a Sandhill Crane (*Grus canadensis*) at Blue Jay--Klamath Marsh is nearby. I observed a flock of ten Water Pipits (*Anthus spinoletta*) on Glaze Meadow at Black Butte. An American Dipper (*Cinclus mexicanus*) and a Warbling Vireo (*Vireo gilvus*) were seen at Canyon Creek. Turkey Vultures (*Cathartes aura*) were seen at the Metolius and S'Ocholis.

WHITE-HEADED WOODPECKER DENSITY

White-headed Woodpeckers were most abundant in old-growth ponderosa pine forest types. Densities across study areas ranged from 0.00-2.53 birds/40 ha. White-headed Woodpeckers detected either between stations or before or after a count period were not included in the density analysis. One White-headed Woodpecker was detected at Whiskey Spring, but not during a count. Also White-headed Woodpeckers were detected outside of point-counts at Canyon Creek. One White-headed Woodpecker was detected at Blue Jay and one at Canyon Creek, but density estimates were not possible for sample sizes less than two. No White-headed Woodpeckers were detected at Wildhorse 91 or Ya Whee either before or after a count period or between stations. Four White-headed Woodpeckers were detected at Doe Butte, but were either detected before or after

a count-period or in between stations and therefore did not enter into the density estimate. One White-headed Woodpecker was detected at a point-count at S'Ocholis, but this observation was not enough to calculate a density estimate. One White-headed Woodpecker was detected during a point-count at Yoss Ridge and three between stations.

DISCUSSION

White-headed Woodpeckers were most abundant in areas that contained a component of old-growth ponderosa pine. They were essentially absent from mixed-conifer sites and those sites that contained younger seral stages. Results from this study support the assertion by Van Horne (1983) that density is not necessarily a valid measure of habitat quality. Wildhorse Ridge, Blue Jay, and Doe Butte are all predominantly old-growth ponderosa pine sites. Density estimates based on these three sites alone would indicate that White-headed Woodpeckers do not inhabit old-growth ponderosa pine forest types. But White-headed Woodpeckers were present on all three of these study areas and successfully reproduced. Bock and Lepthien (1975) analysed Christmas count data and found that neither the White-headed Woodpecker nor the Northern Three-toed Woodpecker (*Picoides tridactylus*) were observed in the montane regions of the west, even though both occur there.

Black Butte supported the greatest species richness. A potential explanation for this is the diversity of habitats present on this study area. The highest density of birds occurred at Canyon Creek. This number was inflated by the high density of Yellow-rumped Warblers on this study area. Wildhorse 91

contained the lowest density of breeding birds. This study area is mostly even-aged ponderosa pine without much of an understory tree or shrub layer.

My results indicate that White-headed Woodpeckers are indeed associated with old-growth ponderosa pine forest types at higher densities than in other forest types and seral stages. However, the assumption that density is positively correlated with habitat quality, must be supported by demographic data (Van Horne 1983). When managing for White-headed Woodpeckers, I recommend that we supplement censuses with nest searches and information on productivity and survivorship.

II. NEST-SITE AND ROOST-SITE CHARACTERISTICS OF WHITE-HEADED WOODPECKERS, WINEMA NATIONAL FOREST

Abstract. I recommend that nest habitat for White-headed Woodpeckers be provided in open stands of ponderosa pine and roost habitat be provided in old-growth stands of ponderosa pine that contain large-dbh ponderosa pine snags. I describe characteristics of 16 nests and 52 roosts of the northern White-headed Woodpecker (*Picoides albolarvatus albolarvatus*) on three study areas in the Winema National Forest of south-central Oregon, 1993. Diameter at breast height (dbh) and height of trees used by White-headed Woodpeckers for nesting and roosting differed significantly (Mann-Whitney U-test: $U = 604$, $P = 0.007$; $U = 146.5$, $P = 0.000$, respectively). Most nest trees (94%) and roost trees (94%) were ponderosa pine (*Pinus ponderosa*). Mean dbh of nests was 80 cm and mean dbh of roosts was 60 cm. Typically nests were low to the ground ($\bar{x} = 3$ m). Mean height of roost trees was 7 m. All nests were in completely dead substrates. Ten percent of roost trees were in live trees, 83% were in snags, 4% were in stumps, and 4% were in leaning logs. The majority of nests (87%) were in moderately decayed substrates; 66% of the roosts in dead substrates were moderately decayed. Mean canopy closure at nest and roost sites was 24% and 44%, respectively. All nests and 96% of the roosts were in ponderosa pine forest types. Mean canopy closure was 24% at nests and 44% at roosts. The majority of nests were in partial-cut old-growth (31%) and overstory removal (44%) stands, and the majority of roosts were in uncut and partial-cut old-growth stands (70%). Eighty-five percent of the roosting observations were in cavities, 4% in crevices, 2% on the trunks, 2% in the fork of a split-bole, and the remaining 8% could not be discerned. Most roosts (94%) were in ponderosa pine (*Pinus ponderosa*), both live and dead.

Key words: nest-site; Picoides albolarvatus albolarvatus; *roost-site; White-headed Woodpecker.*

INTRODUCTION

In Oregon, the White-headed Woodpecker has fallen under the umbrella of the Pileated Woodpecker (*Dryocopus pileatus*); because the corpus of information on White-headed Woodpeckers is limited, it was generally assumed that the habitat provided for Pileated Woodpeckers would suffice for White-headed Woodpeckers. But these two species have different needs and do not use the same type of habitat. In a study of snag use by cavity-nesting birds, White-headed

Woodpeckers used the largest diameter and lowest height and were unique in their nest site selection (Raphael and White 1984). White-headed Woodpeckers use soft dead trees for nests. Furthermore, White-headed Woodpeckers showed one of the strongest preferences for large diameter nest trees (Raphael and White 1984). It is likely that White-headed Woodpeckers will be adversely affected by the removal of large-diameter ponderosa pine on the east slope of the central Oregon Cascades.

Prior to this study, detailed roosting information on White-headed Woodpeckers was nonexistent, and information on nest-site characteristics was primarily for populations in the Sierra Nevada Mountains. Here I describe the characteristics of trees and sites used by White-headed Woodpeckers for nesting and roosting to ensure that management guidelines will include appropriate nest and roost habitat for this species in south-central Oregon.

STUDY AREAS

WILDHORSE RIDGE

Wildhorse Ridge (WR) (42°54´N, 121°31´W) is located 56 km northeast of Chiloquin, in Klamath County, Oregon, at elevations between 1384 and 1479 m. An extensive tract of old-growth ponderosa pine characterizes Wildhorse Ridge and comprises 98% of the study area--the remainder is uncut mature lodgepole pine. Ponderosa pine and lodgepole pine are the overstory dominants in the 896-ha study area and bitter-brush dominates the shrub layer. The herbaceous layer consists primarily of needlegrass and sedges (*Carex spp.*).

DOE BUTTE

Doe Butte (DB) (43°01′N, 121°25′W) is located about 76 km northeast of Chiloquin, Klamath County, Oregon, at elevations between 1468 and 1668 m. Extensive tracts of old-growth ponderosa pine characterize Doe Butte and comprise 86% of the study area--the remainder is comprised of 6% overstory removal ponderosa pine, 1% shelterwood ponderosa, and 6% clearcut.

Ponderosa pine is the overstory dominant in the 832-ha study area and includes one or more of the following tree species in the understory: sugar pine (*Pinus lambertiana*); lodgepole pine; and white fir. The shrub layer is dominated by bitter-brush. The herbaceous layer consists primarily of needlegrass and sedges (*Carex spp.*).

YOSS RIDGE

Yoss Ridge (YR) (42°45′N, 121°37′W) is located approximately 38 km northeast of Chiloquin, Klamath County, Oregon, at elevations between 1385 and 1610 m. (The extended study area for telemetry ranged from 1385 - 1707 m). The forested area of Yoss Ridge is comprised of 49% old-growth ponderosa pine, 29% overstory removal ponderosa, 3% shelterwood ponderosa, 10% mature and old-growth lodgepole pine, 7% shelterwood lodgepole pine, and 3% burn--the remainder is nonforested land.

Ponderosa pine is the sole overstory dominant in the 986-ha study area and includes one or more of the following tree species in the understory: lodgepole pine; sugar pine; and white fir. The shrub layer is dominated by bitter-brush, snow-brush, and manzanita. The herbaceous layer consists primarily of needlegrass and

sedges (*Carex spp.*).

METHODS

NEST SEARCHES

I searched for White-headed Woodpecker nests in each of three study areas between 20 May 1993 and 1 July 1993. Initially, I searched areas where I had detected birds at VCPs and located them by listening for their drums, vocalizations, pecking sounds, or nestlings. After I had checked areas known to contain White-headed Woodpeckers, I searched the rest of each study area by systematically traversing back and forth on foot and checking snags, stumps, and leaning logs for fresh chips or nest cavities. As each snag was checked, I marked it with a logger's crayon. I located all nests on each study area and monitored each nest once a week. I defined active nests as those nests where White-headed Woodpeckers were observed exchanging incubation duties or feeding young.

NEST TREES

For each nest snag I recorded the following: substrate (live tree, snag $\geq$ 1.8 m tall, stump <1.8 m tall, or log); species; dbh; height (measured with a clinometer); decay stage (Cline et al. 1980); presence of disease; percent lean; top condition; percent top broken; percent bark remaining on stem; percent branches; and number of cavities. For each nest cavity, I recorded the following: cavity height; snag diameter at cavity height (dch); cavity dimensions; cavity depth; cavity diameter; and sill width. Not all cavities were safely accessible using ladders. For these I measured cavity height with a clinometer and omitted the other measurements. I described the decay of snags using five classifications (Cline et

al. 1980:780). Stages 2-4 indicate moderately decayed snags; stage 5 indicates advanced decay.

NEST TREE HABITAT

At confirmed nests, I recorded the following information within a 0.4-ha plot centered on the nest tree: elevation; slope; macrorelief; microrelief; position; habitat type; number of understory layers (seedlings, saplings, and/or poles); percent canopy closure; percent shrub cover; number of live stems tallied using basal area factor 10; and maximum canopy height (m).

ROOST TREES

I located each radio-tagged White-headed Woodpecker in a roost tree every two weeks either by following the bird to its roost, or by locating it after dark or before daylight. I marked each roost tree with surveyor's tape and plotted the location on an aerial photo. I returned during the day to measure the roost tree. For each roost I recorded the following: substrate (live tree, snag $\geq$ 1.8 m tall, stump <1.8 m tall, or log); species; dbh; height (measured with a clinometer); decay stage (Cline et al. 1980); presence of disease; percent lean; top condition; percent top broken; percent bark remaining on stem; percent branches; and number of cavities. For each roost cavity, I recorded the following: cavity height; snag diameter at cavity height (dch); cavity dimensions; cavity depth; cavity diameter; and sill width. Not all cavities were safely accessible using ladders. I used the same snag decay classification as for nests (Cline et al. 1980:780).

ROOST TREE HABITAT

I measured the same habitat characteristics at roost sites as at nest sites.

COMPARISON OF NEST AND ROOST TREES

I used Mann-Whitney *U*-tests to test the hypothesis that there is no difference between White-headed Woodpecker nest trees and roost trees. The variables of interest were dbh and height, percent top broken, percent bark remaining, percent branches remaining, percent lean, number of cavities, tree-diameter at cavity height, cavity-height, and number of cavities. I inferred statistical significance when $P \leq 0.05$.

SNAG DENSITY

I took a stratified systematic sample of snags ($\geq$ 25 cm dbh and $\geq$ 1.8 m tall) from 9 different types of strata representing various combinations of habitat type, silvicultural treatment, and seral stage (Table 2). Nonforested areas were not sampled. Each study area contained 3-8 strata. I did not sample a clearcut at Wildhorse Ridge that occupied <0.5% of the study area. Sampling units were 0.4-ha strip transects. The first plot was randomly placed, followed by systematic placement of the remaining plots at 100-m intervals along transects. I sampled snags by counting all snags within a 100 m long by 40 m wide rectangular plot (strip transect) in open stands of ponderosa pine, and 0.04-ha or 0.2-ha circular plots in dense stands of lodgepole pine. I calculated stratified means for each overall study area as specified by Krebs (1989).

RESULTS

NEST TREES

I found 16 White-headed Woodpecker nests on the Winema National Forest--five at Doe Butte, two at Wildhorse Ridge, six at Yoss Ridge, and three outside study

areas. All 16 nests were in completely dead substrates. Thirty-seven percent of the nests were in snags, 56% in stumps, and 6% in leaning logs. Fifty percent of the nests had split boles. Species composition of nest trees was 94% ponderosa pine (*Pinus ponderosa*) and 6% sugar pine (*Pinus lambertiana*). Thirty-one percent of the nest trees had broken tops and 69% had sawed-off tops. The majority of nests (87%) were in moderately decayed substrates (decay classes 2-4). One nest tree was infected with mountain pine beetle (*Dendroctonus ponderosae*).

Mean dbh of nest trees was 80 ± 8 cm SE (n = 16; range = 39-159 cm). Typically nest tree height was low (n = 16; $\bar{x}$ = 3 ± 1 m SE; range = 0.6-16 m). Percent lean of nest trees averaged 5 ± 3% SE (n = 16; range = 0-52%). Percent top broken averaged 84 ± 5% SE (n = 16; range = 20-95%); percent bark remaining averaged 45 ± 8% SE (n = 16; range = 0-100%); and percent branches remaining averaged 2 ± 2% SE (n = 16; range = 0-30%).

Each nest tree had 1-10 nest cavities (n = 16; $\bar{x}$ = 2 ± 0.56 SE). Tree diameter at nest-cavity-height and nest-cavity-height averaged 79 ± 7 cm SE (n = 16; range = 42-152 cm) and 1.4 ± 0.2 m SE (n = 16; range = 0.4-3 m), respectively. Mean diameter of cavity entrances were 48 ± 2 mm SE (n = 16; range = 42-70 mm) and 45 ± 1 mm SE (n = 16; range = 40-55 mm) from top to bottom and side to side, respectively. Mean internal diameter of nest cavities was 92 ± 5 mm SE (n = 16; range = 52-136 mm). Cavity depth averaged 25 ± 2 cm SE (n = 15; range = 19-40 cm). Sill width averaged 42 ± 4 mm SE (n = 16; range = 25 - 80 mm). Bark was present at 25% of the nest holes.

NEST TREE HABITAT

All 16 nests were in ponderosa pine/bitterbrush habitat types. Elevation at nests averaged 1493 ± 15 m SE (n = 16; range = 1426 - 1615 m). Slope gradient averaged 10 ± 2% SE (n = 16; range = 0-33%). Macro-relief at nest sites was 12% buttes, 19% plateaus, 56% minor ridges, and 12% valleys. Micro-relief at nest sites was 31% flat, 6% dissected, 44% convex, and 19% concave. Nest sites were on the top of a slope 25% of the time, on the upper third 25% of the time, on the lower slope 44% of the time, and on the bottom slope 6% of the time. Thirty-one percent of the nests were in partial cuts, 44% in overstory removals, 19% in clearcuts, and 6% in shelterwoods. Thirty-seven percent of the nests were in stands without an understory layer, 44% were in stands with one understory layer, and 19% were in stands with two understory layers. Canopy closure at nest sites averaged 24 ± 4 % SE (n = 16; range = 0-54%); shrub cover averaged 13 ± 3% SE (n = 16; range = 3-30%); large tree basal area averaged 4.3 ± 0.85 m^2/ha SE (n = 16; range = 0-9.3 m^2/ha); and maximum canopy height averaged 27 ± 3 m SE (n = 16; range = 2-40 m). Mean dbh and height of trees surrounding nest trees were 55 ± 3 cm SE (n = 59; range = 11-120 cm) and 25 ± 1 m SE (n = 59; range = 4-40 m), respectively. Ninety-eight percent of the trees surrounding nest trees were ponderosa pine.

ROOST TREES

From 19 July 1993 to 4 November 1993, I found 52 separate roost trees for 14 adult White-headed Woodpeckers (9 males and 5 females). Six roosts were found at Doe Butte, ten at Wildhorse Ridge, thirty-four at Yoss Ridge, and two additional

roosts were found outside of Wildhorse Ridge. The mean number of roosts per bird over a 1-4 month period ranged from 1 to 7 ($\bar{x} = 4$). Eighty-five percent of the roost locations were in cavities, 4% were in crevices, 2% were on the trunk, 2% were in the fork of a split-bole, and the remaining 8% could not be discerned. Male White-headed Woodpeckers roosted in the nest cavity with nestlings until shortly before the young fledged. At Yoss Ridge one White-headed Woodpecker pair (43 Road) used the same roost tree on one occasion.

Ten percent of the roosts were in live trees, 83% were in snags, 4% were in stumps, and 4% were in leaning logs. Species composition of roost trees was 94% ponderosa pine (*Pinus ponderosa*), 4% lodgepole pine (*Pinus contorta*), and 2% sugar pine (*Pinus lambertiana*). Ten percent of the roost trees had intact tops, 83% had broken tops, and 8% had sawed-off tops. The majority of roosts (66%) were in moderately decayed substrates (decay classes 2-4). Four roost trees were infected with mountain pine beetle (*Dendroctonus ponderosae*).

Mean dbh and height of roost trees were 60 ± 3 cm SE ($n = 52$; range = 27-159 cm) and 7 ± 1 m SE ($n = 52$; range = 1-34 m), respectively. Percent lean of roost trees averaged 9 ± 2% SE ($n = 52$; range = 0-68%). Percent top broken averaged 58 ± 4% SE ($n = 52$; range = 0-95%); percent bark remaining averaged 27 ± 6% SE ($n = 52$; range = 0-100%); and percent branches remaining averaged 11 ± 4% SE ($n = 52$; range = 0-100%).

Each roost tree had 0 to 6 cavities ($n = 52$; $\bar{x} = 2 \pm 0.22$ SE). Tree-diameter at-cavity-height and cavity-height averaged 60 ± 5 cm SE ($n = 22$; range = 27-152 cm) and 3.3 ± 0.3 m SE ($n = 45$; range = 1.1-12.7 m), respectively. Mean

diameter of cavity entrances were 51 ± 1 mm SE (n = 22; range = 44-69 mm) and 50 ± 1 mm SE (n = 22; range = 40-64 mm) from top to bottom and side to side, respectively. Mean internal diameter of cavities was 105 ± 6 mm SE (n = 22; range = 60-160 mm). Cavity depth averaged 25 ± 2 cm SE (n = 22; range = 11-42 cm). Sill width averaged 38 ± 2 mm SE (n = 22; range = 20-63 mm). Bark was present at 13% of the roost cavities.

ROOST TREE HABITAT

Four percent of the roosts were in lodgepole/bitterbrush/needlegrass, 48% were in ponderosa/bitterbrush/needlegrass, and 48% were in ponderosa/bitterbrush-manzanita/needlegrass habitat types. Elevation at roosts averaged 1480 ± 8 m SE (n = 52; range = 1395-1634 m). Slope gradient averaged 10 ± 2% SE (n = 52; range = 0-30%). Macro-relief at roost sites was 2% major ridges, 4% plateaus, 73% minor ridges, and 21% valleys. Micro-relief at roost sites was 42% flat, 4% dissected, 21% undulating, and 33% convex. Roost sites were on the top of a slope 21% of the time, on the upper third 23% of the time, on the mid-third 21% of the time, on the lower third 10% of the time, and on the bottom slope 25% of the time. Twelve percent of the roosts were in uncut stands, 58% were in partial cuts, 29% were in overstory removals, and 2% were in clearcuts. Two percent of the roosts were in stands without an understory layer, 42% were in stands with one understory layer, 46% were in stands with two understory layers, and 10% were in stands with three understory layers. Canopy closure at roost sites averaged 44 ± 2% SE (n = 52; range = 3-78%); shrub cover averaged 24 ± 1% SE (n = 52; range = 5-50%); large tree basal area averaged 9.17 ± 0.74 m^2/ha SE (n = 52; range =

0-23.85 m^2/ha); and maximum canopy height averaged 31 ± 1 m SE (n = 51; range = 10-42 m). Mean dbh and height of trees surrounding roost trees were 51 ± 1 cm SE (n = 420; range = 5-127 cm) and 23 ± 0.5 m SE (n = 419; range = 3-42 m), respectively. Ninety-four percent of the trees surrounding roost trees were ponderosa pine, 3% were lodgepole pine, and 3% were sugar pine.

COMPARISON OF NEST AND ROOST TREES

White-headed Woodpeckers did not use the same kind of tree for nesting as they did for roosting. Dbh and height differed significantly between nest trees and roost trees (Mann-Whitney U-test: $U = 604$, $P = 0.007$; $U = 146.5$, $P = 0.000$, respectively). Percent top broken, percent bark remaining, and percent branches remaining also differed between nest trees and roost trees (Mann-Whitney U-test: $U = 689$, $P = 0.000$; $U = 596.5$, $P = 0.006$; $U = 301$, $P = 0.035$, respectively). Percent lean and number of cavities did not differ ($P > 0.05$) between nest trees and roost trees.

Tree-diameter-at-cavity-height and cavity-height differed significantly between nest trees and roost trees (Mann-Whitney U-test: $U = 271$, $P = 0.005$; $U = 90$, $P = 0.000$, respectively). Mean diameter of cavity entrances differed significantly between nest trees and roost trees (Mann-Whitney U-test: $U = 104.5$, $P = 0.034$; $U = 57$, $P = 0.000$, from top to bottom and side to side, respectively). Internal cavity diameter, cavity depth, and sill width did not differ ($P > 0.05$) between nest trees and roost trees.

Mean dbh of trees surrounding nest trees did not differ significantly from those surrounding roost trees (nest sites: 55 ± 26 cm SD, n = 59; roost sites: 51 ±

26 cm SD, n = 420; t = 1.273, $P = 0.207$, two-tailed). Mean height of trees surrounding nest trees differed significantly from those surrounding roost trees (nest sites: 25 ± 9 m SD, $n = 59$; roost sites: 23 ± 10 m SD, $n = 419$; t = 1.981, $P = 0.051$, two-tailed).

Percent canopy, shrub cover, and number of stems differed significantly between nest sites and roost sites (Mann-Whitney *U*-test: $U =$, $P = 0.00$; $U = 196.5$, $P = 0.001$; $U = 182$, $P = 0.001$, respectively). Elevation, percent slope, and maximum canopy height did not differ ($P > 0.05$) between nest sites and roost sites. The majority of both nest and roost sites were in ponderosa pine dominant habitats.

SNAG DENSITY

Because the majority of White-headed Woodpecker nests (87%) were in moderately decayed substrates (decay stage 1-4), I eliminated decay stage 5 snags from the analysis. Sample data for the snag population on each study area are reported in Tables 3-5. The density of snags varied among study areas (Table 6). Yoss Ridge had the highest snag density, Wildhorse the next highest, and Doe Butte the lowest snag density. The reason that Yoss Ridge had an inflated snag density compared to the other two study areas is that the old-growth lodgepole pine stratum contained 18 snags/0.4 ha and the burn stratum contained 12.5 snags/0.4 ha.

DISCUSSION

Raphael and White (1984) classified the White-headed Woodpecker as a soft snag user and reported that most (82%) nests were in snags. Milne and Hejl (1989)

reported that White-headed Woodpeckers commonly nest in fallen logs or leaning snags. In this study, White-headed Woodpeckers primarily used ponderosa pine snags for nests, but also used leaning logs. In addition, eighty-seven percent of White-headed Woodpecker nests were in moderately decayed substrates. Therefore this should be a consideration when developing snag guidelines.

Snag densities in all old-growth strata on the three Winema study areas fell below the recommended density (3 snags/0.4 ha) for old-growth ponderosa pine (Hopkins et al. 1992a). I counted snags ≥25 cm; Hopkins et al. (1992a) only considered 36 cm dbh snags. Had I used 36 cm as the minimum dbh, snag densities in Doe Butte, Wildhorse Ridge, and Yoss Ridge would be even lower. In contrast to this, two out of three lodgepole strata on these study areas exceeded the minimum recommendations of Hopkins et al. (1992b) for snag density in old-growth lodgepole pine.

Based on the number of breeding pairs of White-headed Woodpeckers, I calculated a density of 1.2 birds/100 ha in Doe Butte, 0.45 birds/100 ha in Wildhorse Ridge, and 1.2 birds/100 ha in Yoss Ridge. Although Yoss Ridge was the most fragmented area, it supported White-headed Woodpeckers at similar densities as Doe Butte, which is predominantly old-growth. The most likely explanation for this is that Yoss Ridge still contains large tracts of intact old-growth ponderosa pine capable of supporting breeding White-headed Woodpeckers. Another potential explanation for this is the high snag density at Yoss Ridge. Large diameter high-cut stumps were common at Yoss Ridge and provided excellent nest-sites for White-headed Woodpeckers. But, the majority of these

large stumps and snags were split-boled, which dictated cutting them higher than they would have otherwise been cut.

The mean dbh of White-headed Woodpecker nests in this study (80 cm) are consistent with mean dbh reported in other studies: 56 cm (Frederick and Moore); 80 cm (Milne and Hejl 1989); 64.6 cm (Raphael and White 1984). Raphael and White (1984) suggested that natural selection favors birds that choose larger diameter nest trees. I support the recommendations of Raphael and White (1984) and Conner (1979) to manage for mean diameters of nest trees instead of the minimum diameter known to be used by a species, as recommended by Bull (1978) and Thomas et al. (1979). My data extend the upper limit of minimum dbh for White-headed Woodpecker nest trees to 39 cm.

The majority of White-headed Woodpecker nests in this study were in ponderosa pine. In the Sierra Nevada, the majority of White-headed Woodpecker nests were in Jeffrey Pine (*Pinus jeffreyi*) and red fir (*Abies magnifica*) (Raphael and White 1984). In another Sierra Nevada study, White-headed Woodpeckers nested in Jeffrey pine, white fir, red fir, and sugar pine (Milne and Hejl 1989).

Because White-headed Woodpeckers did not use the same kind of tree for nesting as they did for roosting, and because the habitat characteristics at nest sites varied from that found at roost sites, I recommend that we provide large-dbh snags in an array of habitat structures to accomodate this variability. I also recommend that when carrying out silvicultural prescriptions, we high-cut stumps at ≥2 m to provide additional nest-sites for White-headed Woodpeckers. A word of caution: high-cut stumps are not a substitute for snags. I believe that White-

headed Woodpeckers used a large proportion of stumps for nesting because of intense inter-specific competition for nest-sites. For example, I observed one pair of White-headed Woodpeckers attempting to excavate a nest in a high-cut stump already occupied by a pair of Mountain Bluebirds. The Mountain Bluebirds continuously flogged the White-headed Woodpeckers as they excavated until the White-headed Woodpeckers abandoned the effort. This pair did not renest.

III. WHITE-HEADED WOODPECKER HOME-RANGE AND HABITAT USE, WINEMA NATIONAL FOREST

Abstract. The amount of area required to support a White-headed Woodpecker (*Picoides albolarvatus albolarvatus*) on a contiguous old-growth site is not equivalent to that on a fragmented site--these entities must not be pooled. The implication is that of differential management. Before making habitat management decisions, one must first evaluate the landscape, and then allocate a certain proportion of it to a of bird based on the specific habitat configuration: 212 ha appeared adequate for an individual White-headed Woodpecker in predominantly old-growth ponderosa pine (77-84%) sites--342 ha appeared adequate for an individual White-headed Woodpecker on a fragmented site that contained less old-growth ponderosa pine (50%). This recommendation is based upon radio-telemetry data collected from 12 adult White-headed Woodpeckers on the east slope of the south-central Oregon Cascade Range for up to 3.5 months in 1993. Minimum convex polygon (MCP) home ranges for individual White-headed Woodpeckers were 212 ha (median; range = 172-324 ha) and 342 ha (median; range = 171-704 ha) for contiguous and fragmented sites, respectively. Contiguous sites were predominantly old-growth ponderosa pine (*Pinus ponderosa*) and the fragmented site was a mosaic of all ages of coniferous forest. White-headed Woodpecker home ranges contained 37-92% old-growth ponderosa pine forest. Home ranges were more variable on fragmented than predominantly old-growth sites ($F_{0.05(1),6,4} = 6.16.$, $P < 0.05$). White-headed Woodpeckers selected home ranges that emphasized old-growth ponderosa pine within the landscape and did not establish home ranges at random.

Key words: Compositional analysis; home-range size; old-growth ponderosa pine forest; Picidae; Picoides albolarvatus albolarvatus; *radio-telemetry; south-central Oregon; White-headed Woodpecker.*

INTRODUCTION

The northern White-headed Woodpecker (*Picoides albolarvatus albolarvatus*) occurs throughout montane coniferous forests of the west--chiefly east of the Cascade summit in the Pacific Northwest--and is resident from south-central British Columbia to the southern Sierra Nevada of California (Bent 1939, Jewett et al. 1953, A.O.U. 1957, 1976, Weber and Cannings 1976). Uncommon in Oregon, the White-headed Woodpecker's primary range is in the ponderosa pine belt of the east slope of the Cascades, with isolated occurrences on the west slope and in the

Klamath Mountains (Marshall et al. 1992). Several authors (Dawson et al. 1909, Bent 1939, Jewett et al. 1953, Ligon 1973, Weber and Cannings 1976, Bull 1986) have suggested that the White-headed Woodpecker is closely tied to open stands of mature ponderosa pine (*Pinus ponderosa*) in its northern range. In British Columbia, all but two White-headed Woodpecker sightings were within the range of ponderosa pine (Weber and Cannings 1976), and Burleigh (1972) states that in Idaho "its preference is for mountain slopes covered with open Ponderosa pine, and so partial is it to such a site that it is almost useless to look for it elsewhere."

Eastside Cascades old-growth ponderosa pine forests are considered endangered (Noss et. al. 1995) and have declined by 92-98% in the Deschutes, Fremont, and Winema National Forests of Oregon (Eastside Forests Scientific Society Panel 1993). White-headed Woodpeckers have likely been adversely affected by this decline. A sensitive species in Oregon since 1989, the White-headed Woodpecker was further listed as "Critical" in 1991. The U.S. Forest Service (USFS) Northern (R-1) and Intermountain (R-4) Regions also recognize the White-headed Woodpecker as a sensitive species and have developed a species conservation plan (Spahr et al. 1991, Blair and Servheen 1995).

Despite the White-headed Woodpecker's apparent association with mature and old-growth ponderosa pine forests, no information is available on the spatial requirements and specific habitat use patterns of these birds. Management decisions in Oregon rest primarily on studies conducted in other states and on other woodpecker species within the state. Studies of the northern White-headed Woodpecker are chiefly limited to its foraging behavior and habitat selection (Ligon

1973, Raphael and White 1984, Morrison and With 1987, Morrison et al. 1985, 1986, 1987), nest-site requirements (Raphael and White 1984, Milne and Hejl 1989, Frederick and Moore 1991), status and distribution (Frederick and Moore 1991, Blair and Servheen 1995), and diet (Eastman, Jr. 1960, Otvos and Stark 1985). Raphael and White (1984) found that White-headed Woodpeckers and Black-backed Woodpeckers were unique in their habitat use patterns when compared with other cavity-nesting species.

Regulations set forth in section 219.19 on Forest Planning Actions require the USDA Forest Service to develop forest plans that will maintain viable populations of existing native and desired non-native vertebrate species (USDA 1982). Specific information on home range and habitat use of White-headed Woodpeckers in the Pacific Northwest is essential to comprehensive forest management planning that complies with USDA regulations.

To better understand the relationship between White-headed Woodpeckers and old-growth ponderosa pine, I studied the habitat use of these birds. Here I estimate home-range size, and describe habitat use patterns within arbitrarily defined study areas. Specifically, I compare the effects of forest fragmentation on the home-range size and habitat use patterns of White-headed Woodpeckers on the east slope of the central Oregon Cascade Range.

STUDY AREAS

WILDHORSE RIDGE

Wildhorse Ridge (WR) (42°54´N, 121°31´W) is located 56 km northeast of Chiloquin, in Klamath County, Oregon, at elevations between 1384 and 1479 m.

An extensive tract of old-growth ponderosa pine characterizes Wildhorse Ridge and comprises 98% of the study area. The remainder is uncut mature lodgepole pine. Ponderosa pine and lodgepole pine are the overstory dominants in the 896-ha study area and bitter-brush dominates the shrub layer. The herbaceous layer consists primarily of needlegrass and sedges (*Carex spp.*).

DOE BUTTE

Doe Butte (DB) (43°01′N, 121°25′W) is located about 76 km northeast of Chiloquin, Klamath County, Oregon, at elevations between 1468 and 1668 m. Extensive tracts of old-growth ponderosa pine characterize Doe Butte and comprise 86% of the study area. The remainder of the study area is comprised of 6% overstory removal ponderosa pine, 1% shelterwood ponderosa, and 6% clearcut.

Ponderosa pine is the overstory dominant in the 832-ha study area and includes one or more of the following tree species in the understory: sugar pine (*Pinus lambertiana*); lodgepole pine; and white fir. The shrub layer is dominated by bitter-brush. The herbaceous layer consists primarily of needlegrass and sedges (*Carex spp.*).

YOSS RIDGE

Yoss Ridge (YR) (42°45′N, 121°37′W) is located approximately 38 km northeast of Chiloquin, Klamath County, Oregon, at elevations between 1385 and 1610 m. (The extended study area for telemetry ranged from 1385 - 1707 m). The forested area of Yoss Ridge is comprised of 49% old-growth ponderosa pine, 29% overstory removal ponderosa, 3% shelterwood ponderosa, 10% mature and

old-growth lodgepole pine, 7% shelterwood lodgepole pine, and 3% burn. The remainder of the study area is nonforested land.

Ponderosa pine is the sole overstory dominant in the 986-ha study area and includes one or more of the following tree species in the understory: lodgepole pine; sugar pine; and white fir. The shrub layer is dominated by bitter-brush, snow-brush, and manzanita. The herbaceous layer consists primarily of needlegrass and sedges (*Carex spp.*).

METHODS

TELEMETRY

I captured White-headed Woodpeckers with mist nets in the vicinity of their nests between 28 June and 19 July 1993. Each bird was banded with a U.S. Fish and Wildlife Service aluminum leg band and split-plastic color band, and outfitted with a radiotelemetry transmitter. Transmitters were manufactured by Holohil Systems, Woodlawn, Ontario, Canada, and mounted as a tail-mount, or sutured. For tail-mounts, I first attached three lengths of fly-line backing to the radio and then tied it to the two central rectrices at the base of the tail and secured the knots with cyanoacrylic glue. Sutured radios were attached by slipping two stitches just under the skin between the scapula with 2.0 metric (70 cm) sterile, absorbable chromic gut surgical suture (Taper SH-1). Transmitters averaged < 2g, approximately 3.0% and 3.5% of the average mass of male and female White-headed Woodpeckers, respectively. Transmitter life was about 12 weeks. Following initial capture, I trapped each woodpecker at its roost cavity, and outfitted it with a rebatteried transmitter. I used a mist net basket on a pole similar to the device described by

Jackson (1977) to trap woodpeckers in cavities.

To eliminate potential biases introduced by systematic sampling, I randomized data collection throughout the course of the study by randomly selecting the order in which each study area was monitored each week. I then randomly selected the order in which radio-tagged White-headed Woodpeckers were followed within each study area. I observed woodpeckers directly using radiotelemetry and recorded visual locations, unless the bird was identified to a specific tree or 0.4-ha area. I used Telonics TR-2 receivers and hand-held, directional "H antennas" to detect radio signals. At the beginning of each telemetry bout I recorded bird name and identification number, study area, date, julian date, observer, photograph or map number, and weather (temperature, wind force from Beaufort scale, percent cloud cover, precipitation), time start, and time end.

Telemetry locations were plotted on United States Department of Agriculture (USDA) 1:12,000 aerial photographs or United States Forest Service (USFS) 1:24,000 orthophoto maps (topographic) in the field as they were taken. Each telemetry location was transferred to a master United States Geological Survey (USGS) 7.5-minute series, 1:24,000 orthophoto quadrangle. Only spatially separate locations were plotted, i.e., occasionally each location represented one or more observations, but occupied only one spatial location. I used these locations to obtain minimum convex polygon (MCP) home range estimates.

HABITAT MEASUREMENTS

To determine available habitat within the 3 study areas used for telemetry, I measured habitat variables at plots located throughout each area. Random habitat

plots were centered on the sample point. I sampled within strata and located sampling plots at 100-m intervals. I randomly selected the first plot and systematically spaced the remaining plots. The analysis involved calculating means and variances within each stratum and combining them for an overall estimate based on the area occupied by each stratum within the study area.

I used the variable plot cruising method (Dilworth 1980) to determine live tree basal area (meters square per hectare) for trees ≥ 53 cm dbh. This information may be directly compared to stand exam information on the forests to determine which stands might support White-headed Woodpeckers based on basal area.

I counted the number of stems and each tree tallied contributed equally, without regard to diameter, to the total basal area estimate. Additionally, I measured each stem and recorded its dbh to calculate the number of trees per hectare for trees ≥ 53 cm dbh. For each tree tallied I recorded the species, dbh, and height. I used a "Cruz-all" with Basal Area Factor (BAF) 10 to determine which trees should be tallied. I used the same BAF to sample all plots and selected a low BAF to include more trees per plot and thereby sample a greater area. I determined basal area by multiplying stem count per sample point by the Basal Area Factor (BAF 10) to get basal area per acre and then converted it to basal area per hectare.

In addition to basal area, I also recorded for a 0.4-ha circular plot the plant association (Volland 1988), number of understory tree layers (seedlings, saplings, and/or poles), percent overstory canopy cover (measured directly with a spherical

densiometer), percent shrub cover (visual estimate), and maximum canopy height (m). These are some of the criteria used to classify a stand as old-growth (Hopkins et al. 1992) and were used in conjunction with data on basal area in the larger size classes to determine which stands met minimum old-growth criteria.

Stand exam maps from the Chemult and Chiloquin Ranger Districts were used to stratify each study area by habitat type. I verified this information in the field and recorded the dominant habitat type for each stand. To describe the habitats available to White-headed Woodpeckers on each study area, I took a sample of approximately 20 plots from each of the following strata: clearcuts; shelterwoods; precommercial thins; overstory removals; mature lodgepole pine; old-growth lodgepole pine; partial cut old-growth ponderosa pine; uncut old-growth ponderosa pine; and a burn. I selected plots in this fashion to adequately represent a complete spectrum of the habitat types available. Not all strata were present on all study areas, and because strata were different sizes, the number of plots varied.

I selected an initial starting point from a random numbers table and sampled the remaining points at every 100 m along a series of transects within each stratum. Dbh was measured to the nearest cm with a dbh tape. Height was estimated and periodically checked with a clinometer. Percent canopy closure was obtained by averaging 4 spherical densiometer readings taken at plot center in each cardinal direction (Lemmon 1957, Strickler 1959).

HOME RANGE

I estimated home-range size of individual radio-tagged White-headed Woodpeckers

with the 100% minimum convex polygon (MCP) method (Hayne 1949). Swihart and Slade (1985a) found that over a specified time frame nonstatistical estimates such as the MCP became increasingly accurate as the number of observations increased, even though autocorrelation also increased. I tested for differences in home-range size between sites using a one-tailed variance ratio test (Zar 1984). I used SYSTAT version 5.03 (Wilkinson 1990) for all data analyses and implied statistical significance at $\alpha = 0.05$; however, because sample size (and therefore the power of tests) varies considerably, I considered the biological significance of tests with small sample sizes ($n \leq 12$) at $\alpha = 0.1$.

HABITAT USE

I applied the compositional analysis procedure (Aebischer et al. 1993) to data for 12 radio-tagged White-headed Woodpeckers using the program RESELECT (Leban 1994) to test the hypothesis that White-headed Woodpeckers use habitats in proportion to their availability, and to determine which habitat types were used more or less than expected when the hypothesis was rejected. Aebischer et al. (1993) found that a sample size of ten or more radio-tagged animals adequately represents a population in a use/availability analysis. I compared used to available habitats at one level (see Johnson 1980): home range selection within the overall study area (Johnson's *second-order selection*, Johnson 1980). I tested the following null hypothesis: habitat was used in proportion to its availability in each of 9 habitat categories (Table 2). Uncut and partial-cut old-growth ponderosa pine forest types were combined for the analysis; shelterwood lodgepole pine and shelterwood ponderosa pine were separated for the analysis; an mature and old-

growth lodgepole pine were combined for the analysis.

I extended original study area boundaries to include all habitat blocks containing at least one radio location. One hundred percent minimum convex polygon (MCP) home range estimates were used to define the outer limits of each woodpecker's movements. Habitat compositions within the total study areas and within each woodpecker's MCP home range were measured from USGS 7.5-minute series quadrangles with an electronic digitizing planimeter (Table 7).

RESULTS

TELEMETRY

I radio-tagged 17 White-headed Woodpeckers (9 adult males and 8 adult females) and monitored each woodpecker from 1 to 25 days between 8 July 1993 and 2 November 1993. For various reasons, I was not able to include five of these birds in home range analyses. Three days after trapping the 190 Road Female (DB05B), I found her depredated in an old-growth ponderosa pine stand adjacent her nest stand. She had apparently been killed by an accipiter. I found scattered feathers with the radio still attached to her central rectrices. The 4536 Male (YR01A) lost his sutured radio within 8 days after I trapped him. Blue Jay Female (WR02B) lost her radio within 4 weeks and I was not able to re-trap her. On 28 July 1993, I found Callie Hurd Female (YR04B) depredated. Her radio was still attached to her tail feathers, but all that remained were her feathers and skull. The 4344 Road Female (YR04B) lost her radio within 3 weeks and was not re-trapped. It apparently slipped off her tail and I found it at the base of a large live ponderosa pine tree east of her nest.

On 26 August 1993 I re-trapped Yoss Ridge Male (YR05A) and re-radioed him at his night roost. I placed him in a lower cavity in the snag because I could not reach the original cavity. As I waited to ensure he stayed, I heard two Great-horned Owls (*Bubo virginianus*) hooting. The following day I found him depredated in a lodgepole pine stand southwest of his roost. He had been plucked, his skull crushed, and all that remained was one banded leg. Callie Hurd Male (DB04A) was found dead on 9 September 1993 with his bill caught in his suture. Apparently, a tiny loop in the suture--not visible on the morning I trapped him--was just enough to catch the tip of his bill. On 22 September 1993 I found the radio for 4344 Road Male (YR04A) in a pool of water in a wet meadow adjacent a stand he frequented. There was nothing attached to the radio and no evidence that he had been depredated. It appeared that the sutured radio had fallen off.

I used a total of 897 spatially separate locations for statistical analyses of home range and 1851 telemetry locations for habitat use analyses. Ninety-six percent of the telemetry observations were visual. Due to variable transmitter life and whether a bird was retrapped at a night roost, the length of time a bird was monitored varied.

HOME RANGE

I estimated individual home-range size for 12 White-headed Woodpeckers. MCP home ranges for woodpeckers were 212 ha (median; range = 172-324 ha) in predominantly old-growth sites (Doe Butte and Wildhorse Ridge) and 342 ha (median; range = 171-704 ha) on the fragmented site (Yoss Ridge) (Table 8). Home-range size differed significantly between these sites (Mann-Whitney *U*-test:

U = 7.00, *P* = 0.088). Home-range size variances also differed significantly between sites ($F_{0.05(1),6,4}$ = 6.16., $P < 0.05$), suggesting greater variability among home-range sizes in fragmented areas.

MCP estimates for females averaged 172 ha (n = 1) and 485 ± 111 ha SE (range = 341-704 ha) for contiguous and fragmented areas respectively. MCP ranges for males averaged 247 ± 33 ha SE (range = 175-324 ha) and 293 ± 55 ha SE (range = 171-421) for contiguous and fragmented areas respectively. The male with the largest MCP home range (421 ha) was YR05A and the female with the largest home range was YR05B (704 ha). This pair made use of a high ridge that contained old-growth sugar pine (*Pinus lambertiana*). A large clearcut divided two old-growth ponderosa pine stands within the female's home range.

HABITAT USE

Old-growth ponderosa pine forest was the dominant feature of White-headed Woodpecker home ranges. The overall comparison of habitat use from MCP ranges compared to habitat availability in the study area gave $\Lambda = 0.1782$ (χ^2 = 20.7014, df = 8, *P* = 0.007985), i.e., White-headed Woodpeckers did not establish a home range at random. A ranking matrix (Table 9) ordered the habitats from least to most preferred (left to right):

SPC-Pipo HCC NF HSH-Pipo BUR HSH-Pico HOR-Pipo Pico OG-Pipo

Habitat types underscored by the same line were not significantly different from each other, whereas lack of an underscore indicates that habitat types differed according to the protected least-significant-difference procedure.

Old-growth ponderosa pine (OG-Pipo) and mature and old-growth lodgepole pine (Pico) were the two top-ranking habitat types. Lodgepole pine may have been important because early in the summer--immediately after the young fledged--some of the adults flew with their young into these stands and foraged with them day after day. These stands are dense and they may serve to protect recently fledged young from aerial predators. After this initial time in lodgepole pine stands, the birds spent the majority of their time in old-growth ponderosa pine.

Old-growth ponderosa pine (OG-Pipo) was significantly different than any other habitat except overstory removal ponderosa pine (HOR-Pipo). Although overstory removal ponderosa pine (HOR-Pipo) was not significantly different according to the least-significant-difference procedure, it nevertheless ranked two steps away from old-growth ponderosa pine. It is clear from the ranking matrix that old-growth ponderosa pine stands out as the most important feature of White-headed Woodpecker home ranges.

DISCUSSION

In this study, home-range sizes reflected the overall quality of the habitat; that is, as the amount of old-growth within home ranges or within the study area increased, home-range size decreased. The area required to support a White-headed Woodpecker in a fragmented landscape is larger than the area required to support a White-headed Woodpecker in a contiguous area.

White-headed Woodpeckers made flights up to 13 km presumably to forage on sugar pine seeds on high ridges. Wildhorse Ridge Male (WR01A) traveled 11 km from his usual territory, Wildhorse Ridge Female (WR01B) 10 km, and Blue Jay

Male (WR02A) 13 km. These flights were made in the fall when the birds began to concentrate their feeding activities on pine seeds. All three of these birds inhabited normal home ranges in pure ponderosa pine stands. The large sugar pine trees, with their larger cones and seeds, may offer a resource worth the effort required to obtain them.

MCP home range served to measure the response of White-headed Woodpeckers to the landscape, analogous to second-order selection (Johnson 1980) and in their selection of MCP ranges from within the overall study area, White-headed Woodpeckers selected old-growth ponderosa pine habitat types more than any other. Although lodgepole pine stands figured prominently in the top-ranking habitats--this is likely temporary, and a function of seasonal habitat use relating to the rearing of young.

It is not surprising that White-headed Woodpeckers are closely tied to old-growth ponderosa pine when one considers the overlap in ranges of the woodpecker and the Pacific ponderosa pine. But much of these forests are now dominated by firs, and consequently White-headed Woodpeckers have become rare in some areas. Also, the distribution of ponderosa pine has been profoundly affected by fires (Oliver and Ryker 1990). Larger, thick-barked trees offer effective fire protection whereas competing species, such as grand fir and Douglas fir, are less tolerant. White-headed Woodpeckers might have developed their preference for large-diameter ponderosa pine trees partially as a response to periodic fires. Ponderosa pine has dominated as a seral species throughout large tracts of middle-elevation forests of the West, but because of successful fire control during

the past 50 years, many ponderosa pine stands have developed understories of Douglas fir and true firs (Oliver and Ryker 1990). The harvest of ponderosa pine has accelerated this type conversion, and in the Pacific Northwest, forest cover types on about two million hectares have presumably changed in the last 25 years (Oliver and Ryker 1990).

It is likely that the conversion from ponderosa pine to Douglas fir and true fir will adversely affect White-headed Woodpeckers. There is further evidence for this in the Blue Mountains of northeastern Oregon. White-headed Woodpeckers were uncommon in the Blue Mountains 20 years ago, but today are rarely seen (E. Bull, pers. comm.). After World War I, the Forest Service's major goal in the Blues was to sell ponderosa pine and get the forest "regulated" (Langston 1995). Since World War II, intensive management and logging in the Blues accelerated and resulted in the conversion of old-growth ponderosa pine to even-aged stands of true firs (Langston 1995). The very trees these birds depend on were the ones harvested.

Milne and Hejl (1989) indicated that in the Sierra Nevada, White-headed Woodpeckers were less restricted to pine-dominated habitats than previously suggested. But findings in this study support the White-headed Woodpecker's close association to ponderosa pine forest types in its northern range.

What stand size is required to maintain the integrity of old-growth ponderosa pine? Resource practitioners and research scientists surveyed by Hopkins et al. (1992a) recommended stand sizes of 16-41 ha to protect against losses attributable to root rots, insects, or wildfire. But the necessary stand size depends on the nature of the surrounding forest; if the old-growth stand is surrounded by

younger stands, it must be larger. However, if the stand size is surrounded by mature forest, it need not be as large (Hopkins et al. 1992a).

Previous territory estimates for White-headed Woodpeckers include 8.1 ha for the Blue Mountains (Thomas et al. 1979), 10 ha for the Sierra Nevada (Labinger et al. 1988, Lovio et al. 1988a,b; Milne et al. 1988a,b; Suydam et al. 1988, Milne and Hejl 1989), and 67-445 ha (Dixon unpublished manuscript). Considering that individual White-headed Woodpecker home ranges in this study were from 171 to 704 ha, previous estimates underestimate the amount of area required to support an individual White-headed Woodpecker. The trend in management has been to provide minimums, but Conner (1979) recommends the use of means instead of minimums as the standard for wildlife management--and suggests that if we do not provide "average" habitat, we may gradually eliminate the species we are trying to protect.

In conclusion, resource managers must take a differential approach to providing habitat for White-headed Woodpeckers based on the landscape's configuration. Based on median home-range sizes for individual White-headed Woodpeckers in this study, I recommend that a minimum of 212 ha be allocated to each woodpecker in areas that are predominantly old-growth ponderosa pine, and a minimum of 342 ha in areas that have been fragmented by timber harvesting. Based on the average amount of old-growth present in White-headed Woodpecker home ranges in this study, each area set aside for a White-headed Woodpecker should contain a minimum of 66% old-growth ponderosa pine irrespective of landscape configuration.

This study documents a relationship between old-growth ponderosa pine and the home-range size and habitat-use of White-headed Woodpeckers. I suggest that landscapes be managed conservatively for these birds in the south-central Oregon Cascades.

IV. WHITE-HEADED WOODPECKER BEHAVIOR, FORAGING STRATEGIES, AND MORPHOMETRICS: WINEMA NATIONAL FOREST

Abstract. I examined the behavior, foraging strategies, and morphometrics of northern White-headed Woodpeckers (*Picoides albolarvatus albolarvatus*) in south-central Oregon during the summer and early fall of 1993. Based on 1705 telemetry observations, I found that White-headed Woodpeckers spent the majority of their time (62%) foraging. Gleaning and pecking were the predominant foraging methods of these birds during the summer. White-headed Woodpeckers spent most of their time on the upper trunks and mid-trunks of large-diameter ($\bar{x}$ = 72 cm) live ponderosa pine (*Pinus ponderosa*) and sugar pine (*Pinus lambertiana*) trees in ponderosa pine forest types. Sites where White-headed Woodpeckers were observed were multi-storied ponderosa pine with an average large tree basal area of 9.22 m^2/ha. Mean canopy closure at these sites averaged 54% with a maximum canopy height of 33 m. The only morphometric measurements that differed significantly between male and female White-headed Woodpeckers were mean culmen-length (mm) and weight (g) (t = 3.047, df = 14, P = 0.009; t = 6.388, df = 13.3, P = 0.000, respectively). The use of large-diameter live ponderosa pine and sugar pine trees by White-headed Woodpeckers, regardless of stand type, provides an important management consideration--if silvicultural prescriptions are going to fragment the landscape, they must retain a component of large diameter trees in all harvest units. In addition, we must provide stands with a basal area of large trees ≥9m^2/ha.

INTRODUCTION

The foraging behavior of White-headed Woodpeckers has received more attention by researchers than any other aspect of this bird's ecology. Morrison and With (1987) documented the foraging behavior of White-headed Woodpeckers and compared it to the closely related Hairy Woodpecker. They found a behavioral shift in foraging activity with a general trend toward decreased overlap in foraging behaviors between these two species during the winter (Morrison and With).

Ligon (1973) studied the foraging behavior of White-headed Woodpeckers in western Idaho and reported that White-headed Woodpeckers foraged largely on pine cones. There were temporal differences in foraging behavior and in April, the stomachs of four White-headed Woodpeckers contained 70-90% pine seeds (Ligon

1973).

Hilkevitch (1974) studied sexual differences in foraging behavior in the southern race of White-headed Woodpeckers (*P. a. gravirostris*) and found considerable variation in the use of foraging sites by males and females. Hilkevitch suggested that the longer bill of *P. a. gravirostris* compared with *P. a. albolarvatus* might be correlated with the predominant use of coulter pine (*Pinus coulteri*) by males of *P. a. gravirostris.*

Bull et al. (1986) reported that White-headed Woodpeckers foraged on live ponderosa pine trees by gleaning the trunks; these woodpeckers fed on pine seeds 41% of the time. When dbh was considered, White-headed Woodpecker feeding sites could be distinguished from all species but Williamson's Sapsuckers (Bull et al. 1986).

My objectives were to describe the behavior, foraging strategies, and morphometrics of White-headed Woodpeckers in the south-central Oregon Cascade Mountains during the summer and early fall of 1993, and to describe the habitat characteristics at White-headed Woodpecker activity sites.

STUDY AREAS

WILDHORSE RIDGE

Wildhorse Ridge (WR) (42°54´N, 121°31´W) is located 56 km northeast of Chiloquin, in Klamath County, Oregon, at elevations between 1384 and 1479 m. An extensive tract of old-growth ponderosa pine characterizes Wildhorse Ridge and comprises 98% of the study area. The remainder is uncut mature lodgepole pine. Ponderosa pine and lodgepole pine are the overstory dominants in the 896-ha

study area and bitter-brush dominates the shrub layer. The herbaceous layer consists primarily of needlegrass and sedges (*Carex spp.*).

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Ponderosa pine is the overstory dominant in the 832-ha study area and includes one or more of the following tree species in the understory: sugar pine (*Pinus lambertiana*); lodgepole pine; and white fir. The shrub layer is dominated by bitter-brush. The herbaceous layer consists primarily of needlegrass and sedges (*Carex spp.*).

YOSS RIDGE

Yoss Ridge (YR) (42°45′N, 121°37′W) is located approximately 38 km northeast of Chiloquin, Klamath County, Oregon, at elevations between 1385 and 1610 m. The forested area of Yoss Ridge is comprised of 49% old-growth ponderosa pine, 29% overstory removal ponderosa, 3% shelterwood ponderosa, 10% mature and old-growth lodgepole pine, 7% shelterwood lodgepole pine, and 3% burn. The remainder of the study area is nonforested land.

Ponderosa pine is the sole overstory dominant in the 986-ha study area and includes one or more of the following tree species in the understory: lodgepole

pine; sugar pine; and white fir. The shrub layer is dominated by bitter-brush, snow-brush, and manzanita. The herbaceous layer consists primarily of needlegrass and sedges (*Carex spp.*).

METHODS

MORPHOMETRIC MEASUREMENTS, BEHAVIOR, AND FORAGING STRATEGIES

I collected morphometric measurements from 17 White-headed Woodpeckers--each bird was weighed to the nearest 1 g with a spring-loaded Pesola scale and the unflattened wing and tail were measured to the nearest 1 mm with a Rose wing measure. In addition, tarsus length, crown patch length (males), and culmen length were measured to the nearest 1 mm using vernier calipers. I used a *t*-test to test the hypothesis that there is no difference between five different morphometric measurements of White-headed Woodpeckers. I used SYSTAT version 5.03 (Wilkinson 1990) for all statistical analyses and implied statistical significance at $\alpha = 0.05$.

To obtain information on behavior and foraging strategies, I monitored radio-tagged White-headed Woodpeckers. I recorded the first observation when a bird was initially sighted. I recorded subsequent observations when a bird changed its activity, shifted to a different position on or within the substrate, changed its height by more than 1 m vertically, or flew to a new tree or other substrate. I recorded time of day for each observation. I recorded the bird's activity at each observation as resting, preening, foraging, calling, drumming, flying, threat display, submissive display, feeding young, roosting, other, or unknown. Unknown was used if a bird

moved out of sight or if the location was non-visual. If a bird was foraging, I recorded its foraging method as gleaning, pecking, flaking, sallying, sapsucking, seed or fruit harvesting, or other. I also recorded substrate (live tree, snag, stump, log, brush, ground, air, cones, other), substrate species (ponderosa pine, lodgepole pine, sugar pine, white fir, other), dbh (diameter at breast height, measured to the nearest cm with a dbh tape), and height (estimated in meters and periodically checked with a clinometer). For dead substrates, I recorded decay stage (Cline et al. 1980:780). In addition, I recorded bird-height (m) and position (upper trunk, mid-trunk, lower trunk, branch, foliage).

I recorded plant association, number of understory layers, percent canopy, percent shrub cover, and maximum canopy height at the first telemetry observation for each bird each day within a 0.4-ha area centered on the bird. From a point centered on the bird, I also tallied the number of stems using a Cruz-all with Basal Area Factor (BAF) 10.

HABITAT MEASUREMENTS

To describe the habitats available to White-headed Woodpeckers on each study area, I took a sample of approximately 20 plots from 9 different strata (Table 2). I selected plots in this fashion to adequately represent a complete spectrum of the habitat types available. Not all strata were present on all study areas, and because strata were different sizes, the number of plots varied.

I measured habitat variables at random plots located throughout each area. Random habitat plots were centered on the sample point. I selected an initial starting point from a random numbers table and sampled the remaining points at

every 100 m along a series of transects within each stratum. Dbh was measured to the nearest cm with a dbh tape. Height was estimated and periodically checked with a clinometer. I calculated means and standard errors for each habitat variable of interest.

I used the variable plot cruising method (Dilworth 1980) to determine live tree basal area (meters square per hectare) for trees ≥ 53 cm dbh. This information may be directly compared to stand exam information on the forests to determine which stands might support White-headed Woodpeckers based on basal area.

I counted the number of stems and each tree tallied contributed equally, without regard to diameter, to the total basal area estimate. Additionally, I measured each stem and recorded its dbh to calculate the number of trees per hectare for trees ≥ 53 cm dbh. For each tree tallied I recorded the species, dbh, and height. I used a "Cruz-all" with Basal Area Factor (BAF) 10 to determine which trees should be tallied. I used the same BAF to sample all plots and selected a low BAF to include more trees per plot and thereby sample a greater area. I determined basal area by multiplying stem count per sample point by the Basal Area Factor (BAF 10) to get basal area per acre and then converted it to basal area per hectare.

In addition to basal area, I also recorded for a 0.4-ha circular plot the plant association (Volland 1988), number of understory tree layers (seedlings, saplings, and/or poles), percent canopy closure (measured directly with a spherical densiometer), percent shrub cover (visual estimate), and maximum canopy height

(m). These are some of the criteria used to classify a stand as old-growth (Hopkins et al. 1992) and were used in conjunction with data on basal area in the larger size classes to determine which stands met minimum old-growth criteria.

RESULTS

MORPHOMETRIC MEASUREMENTS

I obtained morphometric measurements for 17 adult White-headed Woodpeckers (Table 16). Mean culmen-length (mm) and weight (g) differed significantly between male and female White-headed Woodpeckers (t = 3.047, df = 14, P = 0.009; t = 6.388, df = 13.3, P = 0.000, respectively). Mean tail-length, tarsus-length, and wing-chord did not differ significantly between males and females (P > 0.05). Male crown-patch-length averaged 9.52 ± 0.58 mm SE (n = 9; range = 6.80-13.05).

BEHAVIOR

I recorded 1705 telemetry observations of White-headed Woodpeckers. White-headed Woodpeckers spent 7% of their time resting, 2% of their time preening, 62% of their time foraging, 6% of their time calling, 0.4% of their time drumming, 14% of their time flying, 2% of their time in threat displays, 0.3% of their time in submissive displays, and 6% of their time in miscellaneous activities. White-headed Woodpeckers spent 38% of the time on the upper trunk, 22% of the time on the mid-trunk, 7% of the time on the lower trunk, 26% of the time on branches, and 7% of the time on foliage. Mean height of birds was 18 ± 0.24 m SE (range = 0-46 m).

White-headed Woodpeckers spent 68% of their time on live trees, 12% of their time on snags, 0.11% of their time on logs, 1% of their time on the ground,

16% of their time in the air, and 4% of their time on pine cones. For dead substrates, 68% were decay class 1, 28% decay class 2, 2% decay class 3, 2% decay class 4, and 1% decay class 5. White-headed Woodpeckers used ponderosa pine (68%) and sugar pine (22%) more than any other tree species. Mean dbh and height of trees used by White-headed Woodpeckers were 72 ± 1 cm SE (n = 1183; range = 7-149) and 30 ± 0.2 m SE (n = 1183; range = 4-48), respectively.

HABITAT AT WHITE-HEADED WOODPECKER TELEMETRY LOCATIONS

White-headed Woodpeckers spent most of their time (86%) in ponderosa pine habitat types. The remainder of their time was spent in lodgepole pine habitat types (9%), mixed-conifer/snowbrush-manzanita (2%), and burns (3%). Three percent of the locations were in stands without an understory layer, 9% were in stands with one understory layer, 24% were in stands with two understory layers, and 65% were in stands with three understory layers. Mean canopy closure at White-headed Woodpecker locations was 54 ± 1% SE (range = 0-94%); mean shrub cover was 25 ± 1 % SE (n = 218; range = 0-60%); large tree (≥ 53 cm dbh) basal area averaged 9.22 ± 0.36 m^2/ha SE (n = 218; range = 0-25 m^2/ha); and maximum canopy height averaged 33 ± 0.4 m SE (n = 215; range = 12-48 m). Mean dbh and height of trees surrounding White-headed Woodpecker locations were 57 ± 0.6 cm SE (range = 4-146 cm) and 26 ± 0.22 m SE (range = 1-48 m), respectively. Eighty-one percent of the trees surrounding White-headed Woodpecker locations were ponderosa pine, 9% were lodgepole pine, 9% were sugar pine, and 1% were white fir.

FORAGING STRATEGIES

I recorded 1053 White-headed Woodpecker foraging observations. White-headed Woodpeckers spent the majority (62%) of their time foraging as follows: 52% gleaning; 40% pecking; 2% flaking; 0.3% sallying; 5% seed harvesting; and 0.3% other. White-headed Woodpeckers foraged 37% of the time on the upper trunk, 25% of the time on the mid-trunk, 7% of the time on the lower trunk, 22% of the time on branches, and 9% of the time on foliage. Mean foraging height was 20 ± 0.27 m SE (range = 0-46 m). White-headed Woodpeckers foraged primarily on large-diameter ponderosa and sugar pine trees (Table 17).

White-headed Woodpeckers foraged on live trees 79% of the time, on snags 13% of the time, on logs 0.2% of the time, on the ground 1% of the time, in the air 0.2% of the time, and on pine cones 7% of the time.

FORAGING HABITAT

White-headed Woodpeckers spent most of their foraging time (90%) in ponderosa pine habitat types. The remainder of their foraging time was spent in lodgepole pine habitat types (4%), mixed-conifer/snowbrush-manzanita (2%), and burns (3%). Three percent of the foraging locations were in stands without an understory layer, 3% were in stands with one understory layer, 17% were in stands with two understory layers, and 76% were in stands with three understory layers. Mean canopy closure at White-headed Woodpecker foraging locations was 54 ± 2% SE (n = 93; range = 0-84%); mean shrub cover was 25 ± 1% SE (n = 93; range = 0-60%); large tree (≥ 53 cm dbh) basal area averaged 9.05 ± 0.56 m^2/ha SE (n = 93; range = 0-22.64 m^2/ha); and maximum canopy height averaged 34 ± 0.6 m SE (n

= 92; range = 17-48 m).

RANDOM HABITAT

Habitat characteristics measured at random plots and the distribution of tree species composition, dbh, and height are presented for each study area in Tables 10-15.

DISCUSSION

White-headed Woodpeckers spent 79% of their time foraging on live trees with a mean dbh of 74 cm. Bull et al. (1986) also reported that White-headed Woodpeckers spent the majority of their time on live trees (80%), and when dbh was considered, White-headed Woodpecker feeding sites could be distinguished from all species but Williamson's Sapsuckers (Bull et al. 1986). Bull et al. (1986) reported that White-headed Woodpeckers foraged primarily on the lower 4 m of the trunk. In this study, White-headed Woodpeckers spent most of their time foraging on the mid-trunk and upper trunk. Large trees provide greater foraging surface area, hence the number of available prey is greater on large trees than on small trees; a bird can feed longer on the same tree, and presumably capture more prey per visit than it would otherwise (Raphael and White 1984). Raphael and White (1984) found that the White-headed Woodpecker was more similar to nuthatches in its overall foraging pattern than to other woodpeckers. Ligon (1973) stated that "ponderosa pine is the only plant importantly utilized by White-headed Woodpeckers".

Other authors have also reported the use of large diameter ponderosa pine trees by these birds (Raphael and White 1984, Morrison et al. 1987, Frederick and

Moore 1991). Large trees provide more food (Raphael and White 1984) and the rugose bark of larger trees supports larger numbers of insects than the smoother bark of smaller trees (Jackson 1979). Furthermore, small trees have less available foraging surface area, and the number of available prey per tree is lower than in a large tree (Raphael and White 1984).

White-headed Woodpeckers spent most of their time in multi-storied stands with a large-tree basal area of $9.22m^2$/ha and canopy closure of 54%. The only stands that contained similar habitat characteristics within the study areas were the old-growth ponderosa pine strata (OG-Pipo and OG-HPR-Pipo) strata.

Although gleaning and pecking were the predominant foraging methods of White-headed Woodpeckers during the summer, these birds began to feed heavily on pine seeds by fall. In early October, three birds flew distances up to 13 km to high ridges dominated by sugar pine and fed almost exclusively on pine seeds. Foraging behavior and diet can vary seasonally and it is important to consider this when managing for a species. Because White-headed Woodpeckers are resident, and depend on a predictable food source to successfully overwinter, we must ensure that we provide appropriate winter habitat. I recommend that in areas set aside for White-headed Woodpeckers, we ensure that these areas contain trees that will provide an abundant seed crop.

In conclusion, the use of large-diameter live ponderosa pine and sugar pine trees by White-headed Woodpeckers, regardless of stand type, provides an important management consideration--if silvicultural prescriptions are going to fragment the landscape, they must retain a component of large diameter trees in

all harvest units. In addition, we must provide stands with a basal area of large trees $\geq 9 m^2/ha$.

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APPENDIX 1

TABLES

BLE 1. Densities (birds/40 ha) of bird species on th chutes and Winema National Forests in 1993 as estimated by the point count method.

Density

Species	Study Area[a]														
	BB	ME	CS	MB	WS	CC	FC	TC	BJ	WI	YW	WR	DB	SO	YR
Northern Flicker (*Colaptes auratus*)	5.54	7.39	13.73	8.71	1.85	6.33	3.70	8.20	0.00	5.28	1.85	0.00	1.85	11.35	0.00
White-headed Woodpecker (*Picoides albolarvatus*)	2.41	2.52	2.53	1.52	0.00	0.00	1.61	2.30	0.00	0.00	0.00	2.07	0.00	0.00	0.00
Williamson's Sapsucker (*Sphyrapicus thyroideus*)	0.95	0.71	1.07	0.83	5.08	1.43	0.00	0.00	0.00	3.92	0.00	0.00	0.83	0.00	0.00
Red-naped Sapsucker (*Sphyrapicus nuchalis*)	0.00	0.00	0.00	0.00	0.00	1.88	3.26	0.00	0.00	0.00	0.00	0.00	0.00	2.33	0.00
Downy Woodpecker (*Picoides pubescens*)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.48	0.00	0.00	0.00	0.00	0.00
Hairy Woodpecker (*Picoides villosus*)	4.49	5.34	0.00	2.77	3.85	3.42	0.00	1.92	0.00	2.78	4.06	3.04	2.35	2.99	0.00
Black-backed Woodpecker (*Picoides arcticus*)	0.00	0.00	0.00	0.00	3.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pileated Woodpecker (*Dryocopus pileatus*)	0.00	1.60	0.00	0.00	0.00	5.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Olive-sided Flycatcher (*Contopus borealis*)	2.18	0.00	9.48	1.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Western Wood-Pewee (*Contopus sordidulus*)	4.68	0.00	3.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Empidonax spp.[b]	28.68	74.56	15.88	8.16	30.40	21.20	21.28	11.44	49.64	9.76	14.16	8.72	3.68	26.28	20.00
Steller's Jay (*Cyanocitta stelleri*)	0.00	1.42	4.74	3.16	0.00	3.16	0.00	0.63	0.00	0.00	3.48	1.11	0.00	3.00	0.00
Gray Jay (*Perisoreus canadensis*)	0.00	0.00	0.00	0.00	0.00	1.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mountain chickadee (*Parus gambeli*)	17.76	12.36	11.76	10.68	14.16	5.36	13.60	80.32	11.96	28.16	16.92	27.24	19.40	17.40	15.44
White-breasted Nuthatch (*Sitta carolinensis*)	2.16	4.33	11.63	9.00	0.00	0.00	5.68	10.28	0.00	1.43	0.00	7.84	12.44	0.00	10.57
Red-breasted Nuthatch (*Sitta canadensis*)	2.56	15.20	4.35	2.40	20.85	12.24	9.21	9.28	22.28	30.70	18.84	17.36	14.04	2.20	7.67
Pygmy Nuthatch (*Sitta pygmaea*)	17.24	7.36	55.80	3.20	0.00	0.00	0.00	30.00	0.00	0.00	0.00	0.00	0.00	19.72	0.00
House Wren (*Troglodytes aedon*)	8.32	0.00	19.48	0.00	0.00	0.00	0.00	0.84	0.00	0.00	0.00	0.00	0.00	2.20	0.00
Golden-crowned Kinglet (*Regulus satrapa*)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00
Townsend's Solitaire (*Myadestes townsendi*)	1.22	1.99	0.00	0.00	0.00	0.00	0.00	1.07	0.00	4.08	1.07	3.83	1.07	2.14	6.27
Hermit Thrush (*Catharus guttatus*)	0.00	4.16	0.00	0.00	7.08	4.48	0.00	0.00	0.00	0.00	7.08	0.00	1.32	0.00	0.00
American Robin (*Turdus migratorius*)	6.08	1.44	3.72	21.72	0.00	4.52	13.60	9.40	0.00	0.00	0.00	0.00	0.00	7.20	0.00
Solitary Vireo (*Vireo solitarius*)	2.44	5.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00
Yellow-rumped Warbler (*Dendroica coronata*)	54.36	44.12	5.80	40.56	71.52	105.68	80.60	76.84	0.00	17.92	27.96	30.84	63.40	16.20	38.44
Black-throated Gray Warbler (*Dendroica nigrescens*)	2.44	8.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dendroica spp.[c]	0.00	2.24	0.00	0.00	21.56	43.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Green-tailed Towhee (*Pipilo chlorurus*)	0.00	0.00	0.72	13.12	0.00	0.00	0.00	1.96	7.76	0.00	0.00	1.63	3.68	0.00	4.16
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	22.28	0.00	15.04	3.72	0.00	0.00	0.00	3.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Chipping Sparrow (*Spizella passerina*)	3.00	8.52	2.16	20.92	27.12	62.96	8.00	11.16	22.28	13.28	39.44	19.08	1.64	27.52	23.24
Dark-eyed Junco (*Junco hyemalis*)	19.28	37.00	17.24	32.60	82.52	92.40	36.80	30.72	35.50	0.00	22.76	10.24	13.88	0.00	3.84
Fox Sparrow (*Passerella iliaca*)	1.96	0.00	2.16	11.52	0.00	0.00	0.00	1.60	0.00	0.00	0.00	0.00	0.00	21.16	3.28
Brown-headed Cowbird (*Molothrus ater*)	11.36	0.00	16.60	71.96	5.24	0.00	0.00	9.20	0.00	0.00	10.12	24.24	10.28	21.16	7.36
Western Tanager (*Piranga ludoviciana*)	15.20	23.72	0.00	2.96	14.88	15.28	0.00	0.00	7.91	0.00	2.64	2.84	1.88	7.84	2.64
Pine Siskin (*Carduelis pinus*)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.88	0.00	0.00	5.00	0.00
Cassin's Finch (*Carpodacus cassinii*)	0.68	11.92	5.60	0.00	3.32	4.20	9.12	0.00	0.00	0.00	6.12	0.60	0.00	10.04	5.44
Total	237.27	281.94	222.61	271.42	312.59	395.46	206.46	300.84	157.33	124.79	180.38	164.68	151.74	210.73	148.35

[a] BB = Black Butte; ME = Metolius; CS = Cold Spring; MB = Melvin Butte; WS = Whiskey Spring; CC = Canyon Creek; FC = First Creek; TC = Trout Creek; BJ = Blue Jay; WI = Wildhorse 91; YW = Ya Whee Plateau; WR = Wildhorse Ridge; DB = Doe Butte; SO = S'Ocholis; YR = Yoss Ridge.

[b] Dusky Flycatchers (*Empidonax oberholseri*) and Hammond's Flycatchers (*Empidonax hammondii*).

[c] Townsend's Warblers (Dendroica townsendi) and Hermit Warblers (*Dendroica occidentalis*)

TABLE 2. Habitat types recognized for analysis of home range and habitat use of White-headed Woodpeckers in the Winema National Forest. Acronyms in parentheses.

Old-growth ponderosa pine forest (OG-Pipo).--Uncut forests containing uneven-aged stands of very late climatic climax ponderosa pine, frequently with a strong component of sugar pine. Canopy height 39 m; canopy closure 51%; basal area (BA) of large (≥ 53 cm) live trees 21 m^2/ha; one to two layers. Stand age generally >200 years. Meets Hopkins et al. (1992a) recommended old-growth criteria for large tree BA.

Partially cut old-growth ponderosa pine forest (OG-HPR-Pipo).--Similar to uncut old-growth, but subjected to partial overstory removal through selective cutting and containing mid-late seral to very late climatic climax ponderosa pine. Canopy height 32-35 m.; canopy closure typically 55%; BA of large live trees 12-15 m^2/ha; one to three understory layers. Stand age generally >150 years. Meets Hopkins et al. (1992a) recommended old-growth criteria for large tree BA.

Overstory removal ponderosa pine forest (HOR-Pipo).--Ponderosa pine forest that has been subjected to removal of the mature overstory to release established immature crop trees that were not a result of a prescribed regeneration cut. One to three layers; canopy closure 22-32%; large tree BA < 5m^2/ha.

Precommercial thin ponderosa pine forest (SPC-Pipo).--Ponderosa pine forest subjected to thinning the pole-sized trees, often resulting from a previous overstory removal. Even-aged; canopy closure 49%; large tree BA < 2 m^2/ha.

Shelterwood ponderosa pine or ponderosa/lodgepole pine forest (HSH-Pipo or HSH-Pipo/Pico).--Even-aged regeneration method leaving an overstory of large-diameter trees typically spaced about >8 trees/0.4 ha with a seedling and/or sapling layer underneath. Canopy height 20-42 m; canopy closure 20-34%; large tree BA 1-7m^2/ha.

Old-growth lodgepole pine forest (OG-Pico).--Uncut forests dominated by ≥30 cm-dbh lodgepole pine trees. Typically one to two understory layers; BA trees (≥30 cm) 13 m^2/ha. Stand age generally >120 years. Meets Hopkins et al. (1992b) criterium for old-growth lodgepole pine.

Mature lodgepole pine (M-Pico).--Similar to above forest type, but either uncut or partially cut, and containing a lower basal area of ≥ 30-cm-dbh trees. Typically one to two layers; canopy closure 50-61%.

Clearcut (HCC).--Clearcut, even-aged regeneration method. Typically contains one layer of seedlings or saplings and may or may not contain remnant merchantable trees. Large tree BA <1 m^2/ha.

Burn (BUR).--Burned ponderosa pine forest containing remnant large-diameter trees.

Nonforest (NF).--Nonforested habitats including meadows, marshes, cinder pits, logging decks, brushy areas, and rock outcrops.

TABLE 3. Stratified systematic sampling of snags in Doe Butte.

Stratum[a]	Stratum size[b], N_h	Stratum weight[c], W_h	Sample size[d], n_h	Mean no. of snags counted per sampling unit, $\bar{x}_h$	Variance of snag counts, s_h^2
A	2550	0.885	64	0.828	1.573
B	167	0.058	19	0.526	0.596
C	32	0.011	1	0.000	1.573[e]
D	132	0.046	18	0.278	0.565
Totals	2881	1.000	102		

[a] 4 strata were delimited based on habitat type: A = partial-cut old-growth ponderosa pine (OG-HPR-Pipo); B = overstory removal ponderosa pine (HOR-Pipo); C = shelterwood ponderosa pine (HSH-Pipo); D = clearcut (HCC). Each sampling unit was a 0.4-ha strip transect. The first strip plot was randomly placed, followed by systematic placement of the remaining plots along transects.

[b] Size of stratum h (number of possible 0.4-ha sample units in stratum h).

[c] N_h/N

[d] sample size in stratum h

[e] due to a sample size of one in stratum C, the variance from stratum A was used to obtain a variance for the stratified mean.

TABLE 4. Stratified systematic sampling of snags in Wildhorse Ridge.

Stratum[a]	Stratum size[b], N_h	Stratum weight[c], W_h	Sample size[d], n_h	Mean no. of snags counted per sampling unit, $\bar{x}_h$	Variance of snag counts, s_h^2
A	262	0.126	20	1.450	3.103
B	1540	0.737	30	0.833	1.454
C	287	0.137	20	5.500	110.300
Totals	2089	1.000	70		

[a] 4 strata were delimited based on habitat type: A = uncut old-growth ponderosa pine (OG-Pipo); B = partial cut old-growth ponderosa pine (OG-HPR-Pipo); C = mature uncut lodgepole pine (M-Pico). Each sampling unit was a 0.4-ha strip transect. For dense lodgepole pine stands, each original sampling unit was a 0.04-ha circular plot; for purposes of analysis, mean numbers of snags per sampling unit and variances were converted to measures per 0.4-ha units. The first plot was randomly placed, followed by systematic placement of the remaining plots along transects.

[b] Size of stratum h (number of possible 0.#-ha sample units in stratum h).

[c] N_h/N

[d] sample size in stratum h

TABLE 5. Stratified systematic sampling of snags in Yoss Ridge.

Stratum[a]	Stratum size[b], N_h	Stratum weight[c], W_h	Sample size[d], n_h	Mean no. of snags counted per sampling unit, $\bar{x}_h$	Variance of snag counts, s_h^2
A	1855	0.461	93	0.753	1.079
B	702	0.174	20	18.000	269.500
C	287	0.071	20	2.200	8.800
D	565	0.140	50	0.160	0.178
E	242	0.060	20	0.200	0.168
F	107	0.027	20	0.450	0.471
G	195	0.048	20	0.200	0.168
H	70	0.017	4	12.500	33.667
Totals	4023	1.000	247		

[a] 8 strata were delimited based on habitat type: A = partial cut old-growth ponderosa pine (OG-HPR-Pipo); B = old-growth lodgepole pine (OG-Pico); C = mature lodgepole pine (M-Pico); D = overstory removal ponderosa pine (HOR-Pipo); E = precommercial-thin ponderosa pine (SPC-Pipo); F = shelterwood ponderosa pine/lodgepole pine (HSH-Pipo/Pico); G = clearcut (HCC); H = bum (BUR). Each sampling unit was a 0.4-ha strip transect. For dense lodgepole, each original sampling unit was a 0.04-ha or 0.2-ha circular plot; for purposes of analysis, mean numbers of snags per sampling unit and variances were converted to measures per 0.4-ha units. The first plot was randomly placed, followed by systematic placement of the remaining plots along transects.

[b] Size of stratum h (number of possible 0.4-ha sample units in stratum h).

[c] N_h/N

[d] sample size in stratum h

TABLE 6. Density of snags* by study area. Data are stratified $\bar{x} \pm$ 95% confidence limits.

Study area	No./0.4 ha
Doe Butte	0.776 ± 0.276
Wildhorse Ridge	1.552 ± 0.721
Yoss Ridge	3.919 ± 1.329

* ≥25 cm dbh and ≥ 2 m tall, and decay stages 1-4.

TABLE 7. Percentage habitat composition within each White-headed Woodpecker minimum convex polygon (MCP) home range and within the total study area. Habitat types described in Table 2.

	% MCP home range								
Bird no.	OG-Pipo[a]	HOR-Pipo	SPC-Pipo	HSH-Pipo	Pico	HSH-Pico	HCC	BURN	NF
Doe Butte									
1	82.86	0.00	0.00	0.00	0.00	0.00	17.14	0.00	0.00
2	62.35	30.56	0.00	2.47	0.00	0.00	4.63	0.00	0.00
Habitat composition (% of study area)									
	76.87	16.05	0.00	1.58	0.00	0.00	5.50	0.00	0.00
Wildhorse Ridge									
3	85.66	0.00	0.00	0.00	13.26	0.00	0.00	0.00	1.08
4	91.86	0.00	0.00	0.00	6.98	0.00	1.16	0.00	0.00
5	91.04	0.00	0.00	0.00	8.96	0.00	0.00	0.00	0.00
Habitat composition (% of study area)									
	83.67	0.00	0.00	0.00	15.61	0.00	0.48	0.00	0.24
Yoss Ridge									
6	38.33	47.50	0.00	0.00	14.17	0.00	0.00	0.00	0.00
7	42.30	27.87	0.00	6.85	17.60	0.98	4.40	0.00	0.00
8	66.37	23.98	0.00	0.00	3.51	6.14	0.00	0.00	0.00
9	79.18	15.54	0.00	0.00	2.05	3.23	0.00	0.00	0.00
10	36.84	41.52	0.00	0.00	5.85	0.00	0.00	15.79	0.00
11	62.47	0.00	0.00	0.00	25.42	0.00	6.41	0.00	5.70
12	52.84	0.14	11.08	0.00	12.07	0.00	20.31	0.00	3.55
Habitat composition (% of study area)									
	49.77	13.57	3.21	0.93	18.73	3.24	7.05	0.93	2.58

[a] OG-Pipo and OG-HPR-Pipo were combined for the use-availability analysis.

TABLE 8. Home-range size (ha) of individual White-headed Woodpeckers, Winema National Forest, Oregon, 1993.

Bird no.[ab]	No.of locations[c]	Days monitored	100% MCP[d]
Doe Butte and Wildhorse Ridge			
DB04A	41	11	175
DB05A	103	20	324
WR01A	65	19	279
WR01B	47	17	172
WR02A	63	18	212
Yoss Ridge			
YR02A	94	25	240
YR02B	107	24	409
YR03A	94	23	342
YR03B	69	19	341
YR04A	78	13	171
YR05A	56	11	421
YR05B	80	21	704

[a] Woodpecker codes: First two letters represent study area (DB = Doe Butte; WR = Wildhorse Ridge; YR = Yoss Ridge); numbers represent nesting pair within each study area; last two letters represent sex (A = male; B = female).

[b] Period of observation: DB04A 20 Jul-7 Sep, DB05A 20 Jul-19 Oct, WR01A 19 Jul-4 Nov, WR01B 13 Jul-14 Oct, WR02A 10 Jul-14 Oct, YR02A 10 Jul-21 Oct, YR02B 10 Jul-21 Oct, YR03A 14 Jul-13 Oct, YR03B 10 Jul-7 Oct, YR04A 15 Jul-11 Sep, YR05A 19 Jul-25 Aug, YR05B 19 Jul-2 Nov.

[c] Number of spatially separate locations.

[d] MCP = minimum convex polygon.

TABLE 9. Simplified ranking matrices for White-headed Woodpeckers are based on comparing proportional habitat use within minimum convex polygon (MCP) home ranges with proportions of total available habitat types. Each mean element in the matrix was replaced by its sign; a triple sign represents significant deviation from random at $P < 0.05$. Habitat types described in Table 2.

MCP home range vs. total study area

	OG-Pipo	HOR-Pipo	SPC-Pipo	HSH-Pipo	Pico	HSH-Pico	HCC	BURN	NF	Rank
OG-Pipo		+	+++	+++	+++	+++	+++	+++	+++	8
HOR-Pipo	-		+	+	-	+	+	+	+	6
SPC-Pipo	---	-		-	---	-	-	-	-	0
HSH-Pipo	---	-	+		---	-	+	-	+	3
Pico	---	+	+++	+++		+	+++	+	+++	7
HSH-Pico	---	-	+	+	-		+	+	+	5
HCC	---	-	+	-	---	-		-	-	1
BURN	---	-	+	+	-	-	+		+	4
NF	---	-	+	-	---	-	+	-		2

ABLE 10. Habitat characteristics ($\bar{x} \pm$ SE)[a] measure .4-ha circular plots within home ranges of White-Hea Woodpeckers at Doe Butte, Winema National Forest, 1993.

	Stratum			
Variable	OG-HPR-Pipo (n = 60)	HOR-Pipo (n = 20)	HSH-Pipo (n = 1)	HCC (n = 27)
Layers[b]				
0	0%	0%	0%	4%
1	0%	95%	100%	96%
2	18%	5%	0%	0%
3	82%	0%	0%	0%
Canopy closure (%)	60 ± 2	22 ± 4	34	23 ± 4
Shrub cover (%)	31 ± 2	21 ± 2	25	21 ± 2
Tree basal area (m^2/ha)[c]	14.73 ± 0.76	0.47 ± 0.08	6.88	0.84 ± 0.15
Maximum canopy height (m)	35 ± 1	18 ± 1	42	19 ± 1

[a] SE could not be calculated for HSH-Pipo because of sample size.
[b] Percent distribution of understory layers.
[c] Basal area of live trees ≥ 53 cm dbh; variable radius plot.

TABLE 11. Habitat characteristics ($\bar{x} \pm SE$) measured on 0.4-ha circular plots within home ranges of White-Headed Woodpeckers at Wildhorse Ridge, Winema National Forest, 1993.

	Stratum		
Variable	OG-Pipo (n = 20)	OG-HPR-Pipo (n = 30)	M-Pico (n = 20)
Layers[a]			
0	0%	0%	15%
1	70%	0%	55%
2	30%	17%	30%
3	0%	83%	0%
Canopy closure (%)	51 ± 3	55 ± 2	61 ± 3
Shrub cover (%)	30 ± 1	31 ± 1	17 ± 2
Tree basal area (m^2/ha)[b]	20.62 ± 1.25	11.97 ± 0.82	5.09 ± 0.39
Maximum canopy height (m)	39 ± 1	32 ± 2	21 ± 1

[a] Percent distribution of understory layers.

[b] Basal area of live trees ≥ 53 cm dbh for OG-Pipo and OG-HPR-Pipo strata and ≥ 30 cm dbh for M-Pico; variable radius plot.

ABLE 12. Habitat characteristics ($\bar{x} \pm SE$) measured -ha circular plots within home ranges of White-Head Woodpeckers at Yoss Ridge, Winema National Forest, 1993.

	Stratum							
Variable	OG-HPR-Pipo (*n* = 78)	OG-Pico (*n* = 20)	M-Pico (*n* = 20)	HOR-Pipo (*n* = 40)	SPC-Pipo (*n* = 20)	HSH-Pipo/Pico (*n* = 20)	HCC (*n* = 23)	Burn (*n* = 6)
Layers[a]								
0	0%	0%	55%	0%	100%	0%	9%	0%
1	21%	90%	45%	50%	0%	100%	91%	100%
2	54%	10%	0%	7%	0%	0%	0%	0%
3	26%	0%	0%	43%	0%	0%	0%	0%
Canopy closure (%)	58 ± 1	77 ± 2	50 ± 2	32 ± 2	49 ± 4	20 ± 3	14 ± 3	33 ± 7
Shrub cover (%)	33 ± 1	0 ± 0	7 ± 1	17 ± 1	17 ± 1	23 ± 1	6 ± 1	0 ± 0
Tree basal area (m^2/ha)[b]	12.75 ± 0.55	13.07 ± 0.78	7.71 ± 0.71	4.30 ± 0.45	1.48 ± 0.14	0.80 ± 0.17	0.98 ± 0.25	8.07 ± 2.60
Maximum canopy height (m)	33 ± 0.4	22 ± 0.79	23 ± 1	30 ± 2	21 ± 2	20 ± 2	18 ± 2	30 ± 1

[a] Percent distribution of understory layers.

[b] Basal area of live trees ≥ 53 cm dbh for OG-HPR-Pipo strata and ≥ 30 cm dbh for OG-Pico and M-Pico; variable radius plot.

TABLE 13. Diameter at breast height (dbh) and height of trees measured on plots within White-headed Woodpecker home ranges at Doe Butte, Winema National Forest, 1993. Values are means ± SE.

Stratum	Species	*n*	%	dbh (cm)	ht (m)
OG-HPR-Pipo	Ponderosa pine	634	97%	58 ± 1	26 ± 0.4
	Lodgepole pine	12	2%	30 ± 3	20 ± 1
	Sugar pine	6	1%	44 ± 8	13 ± 5
	White fir	1	0.15%	75 ± --[a]	--[b]
	All species	653		58 ± 1	26 ± 0.40
HOR-Pipo	Ponderosa pine	67	99%	28 ± 2	11 ± 1
	Lodgepole pine	1	1%	28 ± --	16 ± --
	All species	68		28 ± 2	11 ± 1
HSH-Pipo	Ponderosa pine	3	100%	94 ± 13	41 ± 1
HCC	Ponderosa pine	97	98%	30 ± 2	15 ± 1
	Lodgepole pine	2	2%	21 ± 2	10 ± 0
	All species	99		29 ± 2	15 ± 1

[a] no variance was calculated due to insufficient sample size.
[b] missing data.

TABLE 14. Diameter at breast height (dbh) and height of trees measured on plots within White-headed Woodpecker home ranges at Wildhorse Ridge, Winema National Forest, 1993. Values are means ± SE.

Stratum	Species	*n*	%	dbh (cm)	ht (m)
OG-Pipo	Ponderosa pine	212	94%	77 ± 2	35 ± 0.4
	Lodgepole pine	13	6%	36 ± 4	24 ± 2
	All species	225		74 ± 2	34 ± 0.5
OG-HPR-Pipo	Ponderosa pine	206	100%	66 ± 1	28 ± 0.5
M-PiCo	Ponderosa pine	6	4%	38 ± 12	18 ± 3
	Lodgepole pine	146	96%	25 ± 1	18 ± 0.3
	All species	152		26 ± 1	18 ± 0.3

TABLE 15. Diameter at breast height (dbh) and height of trees measured on plots within White-headed Woodpecker home ranges at Yoss Ridge, Winema National Forest, 1993. Values are means ± SE.

Stratum	Species	*n*	%	dbh (cm)	ht (m)
OG-HPR-Pipo	Ponderosa pine	739	87%	51 ± 1	26 ± 0.3
	Lodgepole pine	15	2%	33 ± 3	23 ± 2
	Sugar pine	93	11%	76 ± 3	30 ± 1
	White fir	1	0.12%	93 ± 0	42 ± 0
	All species	848		53 ± 1	26 ± 0.2
OG-Pico	Lodgepole pine	215	100%	30 ± 1	19 ± 0.3
M-Pico	Lodgepole pine	117	100%	33 ± 1	21 ± 0.3
HOR-Pipo	Ponderosa pine	135	94%	55 ± 2	26 ± 1
	Lodgepole pine	3	2%	30 ± 9	16 ± 5
	Sugar pine	6	4%	47 ± 8	23 ± 4
	All species	144		54 ± 2	25 ± 1
SPC-Pipo	Ponderosa pine	117	100%	34 ± 1	19 ± 1
HSH-Pipo/Pico	Ponderosa pine	24	59%	42 ± 4	20 ± 1
	Lodgepole pine	17	41%	24 ± 2	14 ± 1
	All species	41		35 ± 3	18 ± 1
HCC	Ponderosa pine	45	98%	41 ± 2	19 ± 1
	Lodgepole pine	1	2%	27 ± 0	17 ± 0
	All species	46		41 ± 2	18 ± 1
Burn	Ponderosa pine	24	100	65 ± 3	29 ± 0.5

TABLE 16. Morphometric measurements of adult White-headed Woodpeckers, Winema National Forest, 1993.

Measurement	Males (n = 9) Mean	Males SE	Males Range	Females (n = 8) Mean	Females SE	Females Range
Culmen (mm)	22.98	0.37	21.15-24.50	21.21	0.45	19.20-23.35
Tail length (mm)	67.89	2.64	56.00-80.00	73.25	2.84	62.00-84.00
Tarsus length (mm)	23.77	0.57	21.90-26.90	22.85	0.81	20.10-26.40
Wing chord (mm)	126	1.05	120-131	128	0.84	125-133
Weight (g)	63	1	59-67	55	0.65	53-59

TABLE 17. Diameter at breast height (dbh) and height of trees used for foraging by White-headed Woodpeckers in south-central Oregon, 1993. Values are means ± SE. Sample sizes: ponderosa pine n = 738, lodgepole pine n = 50, sugar pine n = 255, white fir n = 2.

Species	%	dbh (cm)	ht (m)
Ponderosa pine	71%	71.38 ± 0.68	30.36 ± 0.23
Lodgepole pine	5%	32.42 ± 1.51	18.98 ± 0.73
Sugar pine	24%	91.34 ± 1.38	33.22 ± 0.31
White fir	0.2%	76.00 ± 36.00	29.50 ± 8.50
All species		74.00 ± 0.710	30.51 ± 0.20